# AQUAPONICS FOR BEGINNERS

## A step by step complete guide for beginners on how to build their Aquaponics

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Denis Garret

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# Introduction

Congratulations on purchasing *Aquaponics for Beginners*. How does this book differ from others? *Aquaponics for Beginners* walks you through all the steps to produce a successful harvest. Broken down into straightforward steps--from planning to harvesting and everything in between--a checklist of reminders ends each chapter. This book outlines the process, in simple terms, so that everything exists for you to have a successful garden.

Aquaponic gardening continues to become more popular as people seek ways to provide self-sustaining environments for growing fruits and vegetables that require very little maintenance. Using fish and plants, a complimentary blend is created where the fish feed the plants through a waste cleansing process, and the plants feed the fish through a nutrient cleansing process. As the system remains balanced, the fish and the plants virtually take care of themselves.

When it comes to an aquaponic garden, the proof of its success is found in the easy, eco-friendly process and abundant harvest. This one-of-a-kind garden continually gains top-of-the-world attention because it brings together all the best gardening has to offer, including the ability to:

- grow anywhere
- grow any time
- use 90 percent less water
- produce ten times the harvest of a soil garden
- harvest in half the time of a soil garden
- provide maximum nutritional value
- be free from fertilizers
- be free from pesticides
- be free from herbicides
- be virtually infestation-free
- be virtually destructive-free
- use minimal space

When it comes to an aquaponic garden, the hardest decision you'll have to

make is deciding what type of container you'd like to use when harvesting your new produce.

*Aquaponics for Beginners* presents a simple step-by-step program to help you plan, set up, maintain, harvest, and enjoy the most robust garden you could ever imagine. Whether you've grown another type of garden before or this is your first time, this book provides all the information you need to experience this fantastic growth process.

Because of the versatility of an aquaponic garden, every system is different. This is the beauty of the system. You can make one that matches your needs.

There's a lot to learn, but the information you need is easy to understand and apply. Taking a brief look at the internet for ideas can be helpful; however, videos lack the depth required to understand all the dynamics behind each step of an aquaponic system.

There are plenty of books on this subject on the market, thanks again for choosing this one! Every effort was made to ensure it is full of as much useful information as possible; please enjoy!

# Chapter One: Aquaponics Overview

## What is Aquaponics

Dictionary.com defines aquaponics as, “a farming system that circulates wastewater from animal aquaculture to hydroponically cultivated plants, whereby the plants draw nutrients from the waste and filter the water, allowing for its recycled use by the aquatic animals.”

Let’s break this definition down a little bit further:

1. aquaponics is a farming system
2. as part of this farming system, fish are grown in a fish tank where they provide water and wastewater
3. the waste and the wastewater are then piped into the hydroponically cultivated plants, meaning plants that are growing in a soilless environment
4. the plants draw nutrients from the waste and wastewater as generated from the fish tank
5. the waste and wastewater from the fish tank are continually recirculated through the plant bed system, allowing the plants to thrive and provide an abundant harvest

This type of system is a win-win situation for both the plants, the fish, and you. Because of your minimal efforts, you receive a plentiful harvest of vegetables to go along with your grilled fresh fish, a complete meal that is sustainable all year round, anywhere you'd like your garden to grow.

The whole point of an aquaponic system is to create a setup that is low maintenance with a high yield: no weeds, no dirt, no fertilizers, and no watering. The idea behind this garden is to let the fish do the work for you.

To begin building your system, there are a few questions you will want to ask yourself. Look at each of these questions. Get an overall view of all that is considered to put your system together. Then, each question will be answered further to give you more insight as to how each piece works together, so you can find that one that works best for you.

The first questions you will want to ask yourself are:

- What type of system can you afford?
- What type of system would you like?
- What type of fish would you prefer?
- What type of plants do you seek to grow?
- Where would you like your system located?

To answer what kind of system you can afford, you need to know how much aquaponic systems cost. When it comes to building your system, you can go all the way to purchasing a brand-new one, for as much as $10,000, or you can find each piece you need at a garage sale, thrift store, or online for as little as $100.

The next question, what type of system would you like? Following is a list of the most popular aquaponic gardens. Again, this is a simple overview that will be discussed in greater depth in upcoming chapters:

- *Media Based* – this is the most popular aquaponic garden, particularly for beginners. Plants are grown in a container filled with a substance, like expanded clay pebbles—or any other substance that absorbs moisture and nutrients—while keeping air circulating so the plant's roots can get oxygen.
- *Sun Pond* – this system is most like the ancient aquaponic setups. If you are familiar with ponds that are stocked with fish and grow lily pads, this is the perfect example of how an aquaponics system works.
- *One Barrel* – using a 55-gallon barrel, this aquaponic system is all contained within this drum. The media bed is formed from the top third of the barrel, turned upside down, sitting on the bottom 2/3 of the barrel.
- *Two Barrel* – this system uses two 55-gallon barrels. The barrels are cut in half, lengthwise with one barrel used to house the fish and the other barrel used to hold the plants.
- *Vertical Rack* – a vertical rack garden grows plants in a soilless environment vertically (up and down) rather than horizontally (left to right). This allows more room for plants

to grow as they sit in a hole in the vertical pipe. A fish tank is attached, so water can trickle up the pipe and through the system.

- *IBC Tote* – commonly used to transport mass substances, one of these industrial-grade bulk containers is adapted to house the entire aquaponic system. The media bed is made from a cut-off portion of the top, and a fish tank is created from the bottom part.
- *Deep Water Container/Raft Method/Floating* - nutrient-rich water is circulated through long canals at a depth of about 20 cm while rafts (usually polystyrene) float on top. Plants are supported in net pots located in holes of floating rafts. Plants grow out of the top of the platform while nutrient-rich water circulates along long canals.
- *Nutrient Film Technique* (NFT) – this system uses a shallow flow of nutrient-rich fish water, needed for plant growth, to circulate through the bare roots submerged in a narrow channel.

From media bed to shallow water circulations, aquaponics also comes in all kinds of sizes, from containers that can fit on your window sill to multimillion-dollar commercial enterprises.

After considering the cost and type of system, the following are the types of fish that work best in an aquaponic system. Each variety will be discussed in more depth later:

- Tilapia
- Goldfish
- Koi
- Trout
- Catfish
- Carp
- Bass
- Silver perch
- Barramundi

The next question is, what kind of plants would you like to grow? This list includes those fruits, vegetables, and herbs that grow most successfully:

- Basil
- Cabbage
- Cauliflower
- Chives
- Garlic
- Cucumbers
- Tomatoes
- Herbs
- Lettuce
- Onions
- Peas
- Spinach

The question then becomes where you would like to grow your system?

- Inside
- Outside
- Up high, as in suspended from the ceiling
- Down low, as in on the ground

Now that a simple look at the primary considerations for an aquaponic garden has been presented let's look at the theory behind the system.

## The Theory Behind the Aquaponic System

### Nitrogen Cycle

Because nitrogen is vital to every living thing, the nitrogen cycle—or the constant recycling of nitrogen through our biosphere—must be understood. Once this becomes clears, the whole idea behind an aquaponic garden runs becomes understandable.

Nitrogen Cycle:

1. Nitrogen moves through the air then enters the soil (usually through the rain from a lightning storm).

2. In the soil, bacteria break the nitrogen down into ammonium.
3. Ammonium then changes into nitrites and then nitrates.
4. Nitrates become absorbed by the plants.
5. Animals eat plants.
6. When an animal dies, the decomposers—also known as bacteria and fungi—turn the nitrogen back into ammonium.
7. The ammonium changes into nitrogen.
8. The nitrogen cycle then repeats itself.
9. This happens over and over again, sustaining life as we know it.

There is more to this process. Yet, for an aquaponic garden, only the simple steps need to be understood.

The aquaponic system works to duplicate “the nitrogen cycle,” only fish are used instead of animals. The fish provide the waste and wastewater to carry the nitrogen to the plants that thrive in a soilless environment. Then, the plants remove the waste and return the clean water to the fish. This cycle is repeated over and over again to nurture your garden to a plentiful harvest.

This theory of the nitrogen cycle leads to the following overview of how each step works for setting up your aquaponic garden:

1. Set up your fish tank.
2. Create a grow bed where your plants will grow.
3. Add your fish to the fish tank
4. Add your plants to your grow bed
5. Maintain your system
6. Harvest your produce

At first, your system will seem like it's taking a bit of time to set up, much like a soil-based garden. However, as your system becomes more mature and well-balanced, all you’ll have to do is simply "push it along lightly," much like you do a merry-go-round after establishing its first movement. And the result? Fresh veggies and fish harvested right outside or inside your home to serve your friends and family.

Now that you know what an aquaponic garden is and have taken a quick look at what it involves, let’s look at how, and when, aquaponics began.

## Brief History of Aquaponics

Anyone who's ever walked by the edge of a river and noticed a wetland, or delta, can appreciate the successful combination of fish water, the nutrients they provide, and the vegetation that results. The largest delta in the United States is the Mississippi River Delta, at 200 miles long and 87 miles wide.

The oldest form of aquaponics dates to 1000 AD, when the Aztecs created floating islands, also known as Chinampas. Fish water combined with mud and decaying plants resulting in terrific crops of beans, chilies, maize, squash, tomatoes, and other vegetables, like the sun ponds we now know. Together, the natural fish, water, and the process of filtration can create remarkable plants and flowers. Another popular form of aquaponics, developed in Asia, was the use of rice fields for growing rice.

Aquaponics became prominent in the United States in 1969, when Dr. John Todd (a marine biologist who studied the behaviors of fish) and his wife, Nancy (an environmental activist and writer), became focused on creating a more sustainable way to provide food, energy, and shelter. Instead of talking about this subject, they and their friend, Bill McLarney (a fish biologist), decided to do something. As a result, the New Alchemist Institute (NAI) was born. Within this organization, questions were asked, and solutions were found regarding alternative, natural, and ecologically safe and sound, support systems for growing plants and fish.

The NAI started in California, then moved to a twelve-acre farm in Cape Cod, where people became more interested in sustainable ways of providing food, energy, and shelter in a safe environment. A staff was hired to help carry out this mission. Volunteers enthusiastically joined in and, eventually, experiments were conducted using food, shelter, and energy. As a result, new ways of providing sustainable food production, energy, and housing were created. With a strong emphasis on the nitrogen cycle, they knew society was dependent on this cycle to maintain the proper balance of human life sustainability. They also found and emphasized that nature is our greatest ally.

From there, aquaponics became a viable way to use wastewater, rather than the use of chemicals, to raise plants and fish. The process of including a system that involved light, animal, and bacteria, connected through a flow

system, became more established and more popular. This system became known as the Recirculating Aquaculture Tank System (RAS). Going from home to home, business to business, upward and onward, aquaponics became a significant part of the plant growing industry.

In 2017, a story covered the largest aquaponics facility in the world, one thousand miles from the Atlantic Ocean. A 17-million-dollar aquaculture system in Wisconsin houses  120,000 pounds of salmon. Next to this fish system stands a 123,000-square-foot greenhouse that grows six types of greens, sustained by massive amounts of water from the salmon tanks. Both the vegetables and the fish are sold for profit.

## Soil Versus Aquaponic Garden

Just about everyone would love to go into their garden, and harvest produce that is garden-to-table fresh with the highest nutrients available. However, when the choice is a traditional soil garden, many reasons exist as to why soil gardens can take so much work with not as many rewards. Following is a list of soil garden issues with aquaponic garden solutions:

- Soil gardens take too much time – aquaponics takes time to set up also, but with less labor and maintenance. The setup program is simple too. Rather than rototilling, pulling weeds and fertilizer, after an aquaponic garden is set up and the fish are fed daily, the system is designed to run itself.
- With a soil garden, there’s never enough time in the season to grow everything - an aquaponic garden can grow any time of year.
- I do not have the space – with an aquaponic garden; you can pick where you would like to set up your system, either indoor or outdoor.
- I don't have good soil – there is no soil in an aquaponic garden.
- I am not good at gardening – the steps of an aquaponic garden are more exact, making them easier to follow with a lot more understanding of how this gardening system works.
- It takes too much water – an aquaponic garden recycles its water.
- My growing area is full of pests – an outdoor aquaponics system is less susceptible to pests, and an indoor system is virtually pest-free

An aquaponic garden is more comfortable, in that you are working in a clean environment that, many times, is in a more relaxed, waist-high position. Often, working in a soil garden, the outside temperature can get brutal, especially in direct sunlight. Still, with an aquaponic one, the goal is to find a comfortable outdoor temperature or setup one indoors.

## Disadvantages of An Aquaponic Garden

To be fair, the disadvantages should be mentioned too:

*It can be expensive* – however, there are many YouTube videos and online personal stories that show how to cut costs for systems as low as $35. No need to spend the high price that some systems can cost, which can be upwards of $10,000. The whole idea behind aquaponics is to think outside the box. The same can be said about setting up your system.

*The power usage* – again, it depends on how you look at this. There are alternative power sources that work well with aquaponic gardens, such as solar panels or wind turbines.

*Must be professionally installed to work correctly* – aquaponic systems can be installed professionally. However, this is not a must. Anyone can set up an aquaponic system and be successful. Countless people have.

*Looks complicated* – an aquaponic system is no more complicated than a soil system with a lot more benefits, including higher, more nutritious yields in half the growing time.

*If any aspect of setup fails, loss of fish or plants could result*. Risk comes with any garden. In most cases, any type of breakdown in the system takes time to impact the fish or plants directly so that most problems are quickly resolved.

## End of Chapter One Checklist Of Information You Need To Know

- Aquaponics uses the nitrogen cycle theory as the basis for an aquaponic garden.
- Aquaponic garden steps are: set up a fish tank, create a media bed, add fish, add plants, maintain the system, harvest produce.
- Aquaponic gardens were created in the United States in 1969 by

the New Alchemist Institute as a way of providing a safe, environmentally sound, nutritious, vibrant food source.

- Aquaponic gardens have a lot of advantages over soil gardens in that they save time, space, effort, which are simple with higher and more nutritious yields.
- The disadvantages of an aquaponic system are that it sounds complicated, can use a lot of power, and can be expensive.
- An aquaponic system is, in fact, so easy to create that anyone can build one.

# Chapter Two: The Planning Stage

Now that an overview, history, and simple outline has been presented, a more in-depth explanation will be given. In upcoming chapters, each of these steps will be broken down further until all aspects of an aquaponic system have been explained.

The first stage is to decide which kind of system you would like to build.

## Stage One: Things To Consider When Choosing The Design Of Your Aquaponics Garden

Aquaponic gardens are as individual as the stars in the sky. And, just as stars follow the same rules of the universe, and then become their entities, aquaponic gardens all follow the same rules, and then become their garden that works to give you precisely what you want, and need.

The necessary steps for an aquaponic garden are explained within each chapter, in a step-by-step process, including:

- Understanding what an aquaponic garden is--the science behind it and where it all began.

- Building a living fish environment - either a barrel, a container, an aquarium, or any container that holds water, gravel, and all other necessary supporting elements, to help your fish thrive as they do their job to provide nutrients for your garden.
- Building the grow system – this could be a media bed using expanded clay pellets, that sits next to, or on top of, a fish tank. Possibly you will choose a one-barrel or two-barrel garden, vertical rack, Deep Water Container, Dutch System, or Nutrient Film Technique.
- Creating a filtration system – there are two ways to create a filtration system or, in other words, a place where bacteria grow to turn the ammonium into nitrites and then nitrates. One natural filtration system is found in the Media Bed System, where expanded pellets in the grow bed filtrate the fish water. Another type of filtration system, used in a water-based grow

bed (like the Deep Water Container of Nutrient Film Technique) is a bell siphon, which will be explained in more detail later.

- Adding the fish – after you select what type of fish you'd like to grow and build the fish tank, there are a few critical items to follow to keep them safe and healthy while adding them to the fish tank.
- Adding the plants – there are just a few steps to follow for adding your plants as you transplant them from soil to media bed or soil to water.
- Maintaining the system – maintenance steps include feeding the fish, checking the pH balance, and more.
- Harvesting the plants (and the fish, if doing so) – this is as easy as removing the fruit or vegetable from the plant.
- Troubleshooting - how to handle problems that may arise.

Every other detail behind an aquaponic garden is to support the steps mentioned above, from tubing, pumps and drains to fish food, etc. Once these two systems are built, the field becomes wide open as to what you can do to customize your garden to meet your specific needs.

## Specific Aquaponic Systems in More Detail

Each of the different types of aquaponic systems offer a great harvest in half the growing time; however, each one varies from the other. Following is a list of some of the most popular types of systems to help you get a better overview when deciding which system you would like to use:

***Sun Pond*** – the simplest of all the aquaponic systems is the Sun Pond. This system includes a fish-filled pond. The plants float on the water while the roots dangle underneath. Careful consideration is given to the plants to keep the fish from eating or harming them. This type of garden is the closest a person can get to the original delta-style of aquaponics.

***Media Bed System –*** this system is the most popular, especially for beginner aquaponic grows. A fish tank is used to house the fish with a framed media bed on top. (This is a simplified version that does not show the tubes connecting the tank to the fish bed. It also does not show the water pump and air filter. These will be explained later, under the directions for building the

system.

***One Barrel System***- this system uses a big blue, 55-gallon, recycled plastic barrel. This type of aquaponic garden is all-contained into one barrel with the fish tank housed in the bottom, and the top cut off, then flipped to create the media bed. Always make sure the barrel never stored anything toxic.

***Two-Barrel System*** – this system uses two blue 55-gallon barrels. One barrel holds the fish tank while the other one supports the media bed, or the two barrels are cut length-wise and used to support two gardens. More about this system is listed under the How-to Build section.

***Vertical Rack*** – this aquaponic system grows vertically, rather than horizontally. The plants grow from holes cut into the center pipe container while the water flows upward and downward with the fish housed at the bottom of the system. The popularity of this garden comes from its ability to produce a more abundant harvest using less space.

***IBC Tote System*** – known as an Intermediate Bulk Container, this industrial-grade container transports massive amounts of substances. The tote is cut into two pieces. The smaller container is used as the media bed, and the larger container is used to hold the fish. IBC containers come with a cage to support the plastic sides. A media base, like expanded clay pellets, is used in the grow bed for this system.

***Deep Water Container/Raft Method/Floating System*** – with plants that are supported by a floating platform, such as a raft, the roots hang into fish water with an air pump that provides aeration for sufficient oxygenation. The roots are submerged in nutrient-rich water, which is why it is called Deep Water Container. This system is used a lot in commercial aquaponics.

***Dutch Buckets*** – also known as a Bato bucket, these 5-gallon buckets are well-known in Europe and the United States. Benefiting from the fish water exchange, this type of garden is used to provide an individual growing environment for each plant.

***Nutrient Film Technique (NFT) –*** with this system, an irrigation-type system is used. Shallow fish water cycles through a narrow, cylinder-type tube, like a large diameter PVC pipe. The tube, or pipe, has holes drilled in it. The plants are on the outside of the pipe. The roots grow through the holes

and absorb the water inside. This system is very versatile as it can hang from wall-to-wall or suspended from the ceiling. This system can run vertically or horizontally using water so shallow that it is more like a film. Therefore the system is called the Nutrient Film Technique.

With those systems in mind, there are two other aspects of an aquaponic garden that must be considered: biofiltration and a sump tank. A biofiltration system filters the fish waste so that the fishes waste becomes nutritious before it enters a water-based grow area for your plants. (Gardens with a media-based grow bed have a natural filtration system found in the substance used). A sump tank is where the waste is stored.

The following is the information needed regarding the biofiltration system and sump tank.

**Biofiltration**

The name sounds essential and complex. This filtration system is vital for water-based systems. Fortunately, setting up the system is simple. Mainly consisting of a tank or container that is connected to some form of aeration, the tank includes a system of filters that provide an area for bacteria to grow that are needed to turn the ammonia into nitrites and then nitrates to feed your plants.
The biofiltration process has three main parts:

- An air pump that pushes the fish water out of the fish tank and into the biofilter container or tank
- The fish water then goes through the biofilter to change the toxic ammonia into nitrites and then nitrates to feed the plants
- The new plant-healthy water is then sent onto the grow bed to feed the plants.

Some water-based systems use gravity to bring the water from the fish tank to the biofilter. And, because bacteria need oxygen to live and grow, aeration is vital to the biofiltration process.
There are different types of biofilters, including:

- Rotating biological contractors that remove grit, sand, and course material through a screening process, followed by a process that eliminates settled sediment.

- Expandable media filters that provide quick response filtration for processing water with high concentrations of solids
- Fluidized filters filter the fish water then push the water through to the system.
- Trickle filter is any contained, packed media that has water trickling over the top of the media.

Purchasing a biofilter is an option, but those that are homemade can be superior to store-purchased ones because of their ability to be customized precisely to meet your system's needs.
Things you need to know about biofiltration:

- Ideal temperature is 63-93 degrees Fahrenheit
- Optimum pH is 7.0 to 9.0
- Biofilters overall condition of effectiveness is checked by monitoring ammonia and nitrate levels routinely
- Optimum level for dissolved oxygen (DO) is 4 to 8mg/liter
- Protection from the sunlight is a must as bacteria is sensitive to ultraviolet light, at least until the biofilm is mature

The concept behind a biofilter is that nitrification can happen on every surface of the system water contacts. The biofilter tank makes this happen. Both the clarifier and the biofilter tank should hold 15 to 20 percent of the fish water in the tank.

For the biofilter tank to work correctly, it needs two things:

- A surface media that has a surface area high enough for the colonization of nitrifying bacteria
- For the bacteria to have sufficient aeration

Commercially sold biofilter media, but other materials can be used, such as:

- Material used for packaging
- Lava rock
- Bottle caps made of plastic

The most important thing is that the media is free from any chemicals or substances that would harm your system, so some effort should go into

making sure you know the history behind the container you choose. The container should be able to be easily cleaned using de-chlorinated water and not weigh very much. Again, aeration is vital. This is because the microbes that transplant the media need an oxygenated environment to thrive. The ideal dissolved oxygen level for the biofilter tank is five ppm. Sporadically mixing the media will help secure the efficiency of the media by guaranteeing the water flow does not bypass active surface areas.
Biofilter Process:

1. Water from the fish tank goes into a biofilter tank/container
2. The goal then is for twice as much water to get air exposure (some growers add a T-pipe at the end of the tubing or piping, so the water flows out like a fountain from both sides. This allows aeration to happen at its maximum. This is important for gas exchange, removing carbon dioxide and adding oxygen into the water.
3. A thick screen that fits snug to the wall is set in place.
4. Placing a filter pad
5. Bio balls are added. These are small spheres with open spaces where bacteria can grow, taking ammonia from fish and converting it into nitrite/nitrate.
6. Oxygen is added.
7. Water then flows into the plant system before returning to the fish tank.

**Sump Tank**

A sump tank is a container where water-run-off from the grow bed accumulates. A sump tank is always positioned lower than the grow bed. The water of a sump tank goes in and out of a grow bed, leaving the fish tank alone. When the water level rises in a sump tank, a float switch turns the pump on and moves water back to the fish tank. Water from the fish tank then drains by gravity to either the grow bed or sump tank. One advantage of a sump tank is that it allows you to add more grow beds, even as much as one fish tank to three grow beds.

The goal of a sump tank is to allow the fish tank height to remain steady, no matter how full or empty your grow bed becomes. A sump tank allows this because the varying water levels now shift from the fish tank to the sump

tank.

The sump tank should be large enough to handle all the flow that comes in from full grow beds. To figure this out, total up the water volume of your grow beds, then subtract the factor effect of the growing media. Then, add up the amount of water that needs to remain in the sump tank to cover the pump and guarantee the sump does not run dry or burn out. Three inches might be sufficient, but pump intake has different heights. This amount added to the grow bed water is the minimum volume you need, also referred to as the CHIFT PIST (Constant Height In Fish Tank Pump In Sump Tank) or CHOP (constant height one pump) systems.

When it comes to what system to choose, make sure the system, with all its plants and fish, fits your lifestyle. That the system is easy, simple, and provides the results, you desire year after year.

After you select the right design for you, stage two can begin, meaning what size of the garden would you like to have?

## Stage Two: Things to Consider When It Comes To The Size of Your Aquaponic Garden

Fortunately, the beauty of an aquaponic garden is that it can be whatever you need and want it to be. This is because an aquaponic garden can cater nicely to the amount of space you have available. Some people choose to build a Mason jar aquaponics system that stands in their kitchen window sill while others enjoy the commercial size of a system, like the 123,000 square foot commercial version in Wisconsin.

One thing to keep in mind, when considering the size of your garden, is the amount of plants you'd like to grow, and then you'll need the proper amount of fish to supports this. When assembling an aquaponic garden for the first time, the fish-to-grow-bed ratio should be of equal amounts. This means the size of the fish tank should be the same size as the grow bed. Other calculations are:

- Eight pounds of fish, at their full weight, equals one 8-square foot of grow bed.
- Eight pounds of fish equals a 40 to 56-gallon fish tank.

More of this will be discussed later, after the reasoning behind the balancing of this system is explained.

When figuring out the size of your system, it is essential to remember that, for your system to function at its best, the optimal balance must be maintained between fish-generated-nutrients and plant-nutrient-absorption. If, for some reason, the plants are unable to filter the fish waste and water, highly toxic amounts of ammonia and nitrates will return to the fish and kill them. For instance, if there are too few plants, they will not be able to do the job required to remove the nitrates and ammonia that could prove deadly to your fish. And yet, an overabundance of plants is not the answer either because this, too, creates other issues. A reduction or excess of fish is not the answer. Fortunately, this is a tried and tested system, so there are simple formulas that need to be followed to get the best balance.

This exchange between fish and plants might sound a little complex, but it is not. The process just needs to be understood. When working with a traditional backyard, soil-based garden, there is soil, fertilizer, watering, plants, and pests to consider. In an aquaponic garden, the balance must be found between the:

- ☐ fish species
- ☐ plant choice
- ☐ system size
- ☐ system design

Let’s break this down, so you can see how each one plays into the other to create the balance needed:

***Fish species*** – every fish provides the waste needed for your garden. In return, those fish need plants that can absorb the nutrients, and then return fresh water for the fish to live in. So, the amount of fish waste is related to the number of plants. Some fish need higher nutrients, and some need lower nutrients. Some fish need warm temperatures, while others require cold temperatures. We will continue to define each fishes' needs as we get further into this boo. This will help you choose the right fish for your system, meaning ones that co-habitat well together and match up with the needs of your plants, amount-wise.

***Plant choice*** – plants are like the fish in that each plant has different needs when it comes to nutrients, temperature, grow bed, and water. For instance, low to medium amounts of nutrients are necessary for leafy vegetables, onions, cabbage, cauliflower, and lettuce. Plants that require higher levels of nutrients include tomatoes and cucumbers.

***System size*** – in many ways, the size of your system is dependent upon its ability to convert fish waste (ammonia) into nitrates. The nitrates then turn into food for the plants. Simply put, the larger the grow bed, the more fish you will need. The same is true for your plants. The essential fact in all of this is the Biological Surface Area (BSA). The BSA, otherwise known as user-space efficiency, is the heart of every aquaponic system as microbes do the work for you. BSA must be understood to maximize the production of your aquaponic garden. Many growers overlook this critical aspect that shows the number of bacteria you have and need, to do the job of turning ammonia into nitrites or nitrates.

BSA is usually measured:

1. Using the number of square feet in a system
2. Number of square feet in a system is known as the specific surface area (SSA)
3. The SSA is the number of square feet per cubic foot
4. The SSA equals the amount of square footage in the media area.

In other words, if you have a handful of rocks and need to come up with the BSA of that handful, you need to know how many square feet of surface area is inside of one stone. Once you figure this out, you can then add the number of rocks in your hand together, and you will have the SSA of your handful of stones.

Specifically, the formula for this is:

_ multiply the height of your grow bed
_ by the width of your grow bed
_ by the depth of your grow bed
_ and this will equal the total inches of your grow bed.
_ Since 1,728 cubic inches = one cubic foot,
_ divide the total inches of your grow bed by 1728 inches

- and you will have the square cubic feet of your grow media.

If you're stocking fish at 1 pound per 10 gallons of water, you'll need 25 ft2 of BSA - This will be the amount you'll need for adequate waste and ammonia processing.

Suffice it to say that, for nitrification purposes, 2.50 square feet of BSA per gallon of water is the bare minimum and not recommended. Ten square feet of BSA per gallon of water is more recommended. The standard formula is, for every pound of fish, 25 square feet of BSA is needed to process waste and to process ammonia-rich water and keep water healthy. Young systems need more BSA, and most systems work with 25 square feet of BSA.

***System design*** – fortunately, there are a lot of choices when it comes to aquaponic systems. The design of the system comes into play because some plants work better with some systems, and when it comes to size, small size systems work better with some designs rather than others.

Each aspect works together to provide success for your preferred garden. So, when it comes to the kind of plants you'd like to grow, this blends with your preferred fish. The amount of fish and plants you need determines the size, and each design supports each fish, plant, and size the best.

Let's take a look at the size of the system you might want to choose and what options there are to consider when deciding how big, or small, you'd like your system to be.

## Stage Three: Things To Consider When Choosing The Location

When it comes to location, there are a lot of good things to remember, so your garden can be safe, secure, and prosperous:

*A safe environment* – this is first and foremost. If you don't have a safe environment for your plants and fish, then they will not survive. Plants and fish are vulnerable, which is why they must be in a protected environment. The area should be free of any animals, especially those prone to want to eat the fish. Children and grandchildren should be discouraged from going near the garden, so no harm is done to either the garden or them. Pay attention to what pests might be in the area that could harm your system (caterpillars, snails, etc.) Determine the temperature and make sure it is not too hot or too

cold. And make sure you have sufficient space for access to every part of your system.

*Ground durability* – the number one question to ask yourself is, "Can the flooring I choose support the system?" Keep in mind that 8 ½ pounds of water equals one gallon, so make sure you weigh your system to its maximum amount before you start. This way, you will know that the ground you choose can support the water weight. You'd be amazed by how easily a system can reach one ton of water.

*Cleanliness of area* – your garden will need to remain clean and safe. Is there a hose nearby? Can the ground be easily cleaned and dried, so no one slips? Your system will need fresh water, at times, because of natural evaporation. Is there a sink nearby? A sink is helpful to wash all garden items, your hands, etc.

*Proper electricity* – having an outlet nearby is helpful, if not necessary. Make sure it is off the floor and free from any water. Backup power is also a good idea, as the plants and the fish can suffer in a power outage. If you do not have a backup system, a plan of what to do is necessary. This will be discussed under the troubleshooting section of this book.

*Adequate ventilation* – your garden will need fresh air that is continually circulating without strong winds or no movement at all. Make sure your area has a lot of open space for the air to move.

*Right climate* - special attention needs to be paid to the correct temperature. It should have the ability to be as stable as possible. The humidity should also be appropriate, not too much or too little. Just remember it is easier to heat something up rather than cool something down.

*Sufficient lighting* – lighting is vital to your plants. Lighting considerations include how much lighting time your plants should receive and making sure your plants receive the correct light spectrum. Different lighting systems should also be considered, as well as what each light does, which type of lighting can each plant absorb the best, heat output, energy needs, and cost.

We have explored the type, the size, and the location of your system. Now it's time to set up a sample aquaponic garden, so you can get an idea of what the process involves.

## Checklist for Chapter Two: Planning Stage

- Aquaponic gardens are designed to meet everyone's specific needs.
- Eight of the most popular types of aquaponic gardens, included in this book, are Sun Pond, One Barrel, Two Barrel, Vertical Rack, IBC Tote, Deep Water Container/Raft Method/Floating, Dutch Bucket, and Nutrient Film Technique.
- The garden size depends on the number of plants for harvest, with an equal ratio of fish-to-grow bed, meaning the size of the fish tank is equivalent to the size of the media bed (one 8-square foot media bed equals eight pounds of fish, at their full weight).
- Four parts to consider when balancing the system are fish species, plant choice, system size, and system design.
- There are two types of filtration systems: grow bed and biofilters.
- When choosing a location, the following must be considered: a safe environment, ground durability, cleanliness of the area, proper electricity, sufficient space, right climate, adequate lighting.

# Chapter Three: Fish System Setup

## Setting Up The Tank and Grow Bed

The first step in every aquaponic system is the fish tank. Why? Because, even though the installation does not take long, the resting period for the water does, as time is needed to calm down the chlorine factor and build up the bacteria so the tank can do its job. For this reason, it is wise to start with the fish tank and allow it to mature while working on the other aspects of your garden.

Keep in mind that bright lighting encourages algae in a fish tank. Make sure to point the direct light away from the tank, so it does not directly affect the

tank. Should your lighting produce algae, you can purchase an algae brush. Some growers will buy a fish that eats algae. But make sure this fish is compatible with your other fish.

Also, fish do not like sunlight, which is why you'll always see lily pads or additional growth in a natural pond that has fish inside. Most fish tanks to have a fluorescent light in them so that you can monitor your fish. The decision is yours. You can have a light or decide not to.

The following are the directions needed to build a fully equipped Media Bed System. In each of the different aquaponic garden systems: a one-barrel or two-barrel system, vertical rack system, Deep-Water Container, Nutrient Film Technique, the fish tank system is virtually the same as the Media Bed System example that will be shown.

Materials needed:

- A fish tank or aquarium (can be purchased at a pet store, superstore or online)
- A small water pump (home-improvement or superstores sell these)
- Aquarium air pump (pet store, superstore or online)
- Airstone (pet store, superstore or online
- 3 ft. of air tubing to fit the air pump outlet
- Drill with bits
- Electrical tape
- 2" Plastic Water Pump Replacement Strainer (online)
- Fish
- Grow container
- Growing medium
- Plants
- pH test kit, pH down and pH up
- Scissors
- Tools

Directions:

1. Decide the size of your grow bed, the weight of your fish, (1

pound of fish for 1 square foot of a 12” deep grow bed.

2. Select the size of the fish tank by following the rule of 1 pound of fish for every 5 to 7 gallons of water
3. The fish tank can be an aquarium or a plastic bucket, barrel, or homemade from plexiglass:

a) fill the bottom with gravel.
b) add the air stone to the air pump, then place this in the tank.
c) place a water pump on the bottom of the aquarium.
d) add a tube long enough to reach the hole near the top of the grow bed when it is placed on top of the fish tank. Do not plug in pumps.

4. Take a rectangular plastic container that is a little bit larger than the fish tank. Drill a hole at the short end of the container. The hole should be centered, but one inch away from where the edge of the bottom meets the edge of the sidewall (see diagram below). Put either a strong tubing or something sturdier, like a cut-off portion of a syringe barrel, through the hole. One inch of the tube should be inside the container, and two inches should be outside the container. Attach a tube onto the outside portion of the drain, so the water can flow from the grow bed container to the fish tank. Glue in place.

b. at the opposite end of the container, make a ½" hole near the top, centered in the middle. This is for the water to go from the fish tank into the grow bed. Put a tube in the hole. Let the tube hang on the outside in preparation for putting it into the fish tank.

5. Cover the drain with a 2" Plastic Water Pump Replacement Strainer.
6. Place the grow bed on top of the fish tank. Take the tube attached to the drain. Set the open end of the tube into the fish tank. This is how the water drains from the grow bed back into the fish tank.
7. Fill the tank with water that is 95% of the way from the top of the container. Add well-washed gravel to the bottom of the tank Set the water pump onto the bottom of the tank. Add tubing to the water pump, making sure the tube is carrying water from the fish

tank into the grow bed, then draining back down into the fish tank through the tube at the grow bed's other end. Make sure to adjust the flow so that it trickles in and out at a pace of one entire circulation per hour. Attach the air stone to the air pump and set this in the tank so bubbles can provide fresh air. Plugin the water and air pump. Add media, like expanded clay pellets, some of which have been tested in a cup of vinegar—if the pellets fizz, they contain limestone. Wash the pellets in water, then add them to the media bed.

8. Check for any leaks where the water enters and exits and repair as needed.
9. Flood and drain the grow bed using a timer. Run the timer for 15 minutes on and 45 minutes off. The grow bed should receive all the fish tank water every hour, meaning if you have a 50-gallon tank, you need a 200 gallons per hour pump. Keep in mind the lift, meaning moving the water against gravity, using the information that is on the pump packaging.
10. Test the pH balance of the water using litmus paper, a test kit, or pH meter. The water should be at 7.0 pH. If it is lower than 6.8, add "pH up." If it is higher than 7.2, add "pH down."
11. Your system should now rest for 24 hours. This allows for any chlorine to be removed and for bacteria to grow.
12. Twenty-four hours from the completion of your system setup, when the ammonia and nitrite levels are below 1.0 ppm, you can add your fish. Begin by adding ½" of fish per gallon of water. Four weeks after the introduction of your fish, you can increase this to 1" of fish per gallon of water.
13. Ideally, you should wait approximately four weeks to add plants to your system, but if you are eager to plant them, just add a few plants, then increase the amount of plants in a month.
14. Shade or some type of covering prevents algae from growing in fish tanks.
15. Heating the water to the right temperature can be expensive. When heating fish tank water, consider insulation or putting system close to house or building (to slow down the heat).

Any type of container can work, but a circular container is the best. The

reason a circular tank is more advantageous is that the waste does not collect in corners and must be cleaned like it does in a regular tank. And the fish waste can float in the water better. Plus, the water and the fish can circulate better.

A variety of different types of materials can be used:

- UV-protected plastic
- Fiberglass
- A bathtub
- Any container that is sturdy and heavy-duty enough to withstand the pressure from a significant amount of water
- Any food-safe-type plastic like polyethylene HDPE or fiberglass,

Materials that are not recommended include:

Metal and wood because they can destabilize the pH balance
Recycled plastic is not a guarantee when it comes to safety—who knows where it's been.

The top of the fish tank/container should be as wide as possible. Should you have to choose between a lower and broader container rather than a narrower and taller container, choose the lower one because the wider the surface area, the better the oxygen exchange.

Larger tanks are better than smaller tanks when it comes to pH balance; a larger tank is better because the larger tanks usually have less fluctuation in the pH balance. IBC totes are amazing for their durability and "caging system" that allows them to be moved around easily.

An average aquaponic fish tank usually holds 300 gallons of water. With one fish for every 10-gallons of water, this would translate into 30 fish for your first 300-gallon tank. Keep in mind that the amount of fish for this size of the tank can vary. New gardeners might not want to manage this amount of fish, so this might not be ideal for specific aquaponic garden systems.

You must include a water pump sufficient to cycle the fish water to the plants and back again. Water pumps can be found online or at any home improvement store. More about pumps will be discussed in an upcoming chapter and throughout the book.

Water should cycle through your system up to one time per hour or 24 times per day.

Water dichlorination takes between 4 to 6 weeks of cycling the water before fish are added. During this time, bacteria can build and become sufficient to break the ammonia down into nitrates so your plants can use them for food.

Fish tank must be covered, so fish do not jump out  Contrary to what a lot of people think, fish do not need light. Fish prefer shade. Shade makes them feel more secure. Some gardeners choose to use netting to cover their fish tank, but this does prevent the fish from getting out. It also does not prevent foreign objects from getting in. It also does not protect the fish from predatory animals or birds. Covers can be made from shade cloth with zip ties to attach the cover to the tank. The fish tank cover should never get in the way of the fish food that floats on the top of the water.

Never use copper pipes. Simply put, copper kills fish.

## Balancing pH In Your System

The target pH balance of an aquaponic fish tank is 7.0. This figure represents the proper balance for both the fish, the plants, and the bacteria. Broken down further:

- Fish require a pH balance of 6.5 to 8.0
- Plants require a pH balance of 5. 0 to 7.0
- Bacteria requires a pH balance of 6.0 to 8.0

Average this out, and you get 7.0 for all three.

During the initial setup of your tank, the pH may be higher. This is normal for the cycling process. The pH will lower as the dichlorination process calms down, and the bacteria begin to grow.

The pH should be tested 3 to 4 times weekly with a pH balance test kit.

Should you need to lower your pH level, this is, most likely, because:

- Hard water is being used from the faucet or hose
- Carbonate is built up within the system
- The grow bed media contains limestone
- Concrete is somewhere in the system

Should you need to raise your pH level, this is, most likely, because:

- For some reason, the nitrification process is causing an acidic effect and lowering your pH
- Something isn't right with the materials in the fish tank or plant grow bed

If you find that your pH levels are going from high to low, even throughout one day, it might be time to check the KH (carbonate hardness) levels. A KH test will need to be purchased online or at a fish or pet store to measure the strength. If the KH level is above 4.0, retest in a week. Keep in mind that as your system establishes itself more, increased nitric acid will be the result, and the KH level will naturally lower. If your KH level is below 4.0, add 2 ½ teaspoons per 100 gallons of potassium bicarbonate for each KH level you need to rise or follow the directions that come with the potassium bicarbonate product you purchase. The optimal level for your water is four dKH. Without this level, you will need to test the pH level daily.

Be careful when using natural calcium carbonates, like egg, snail, or seashells. While they are safe, they can take a long time to take effect. Because of this, you could test your pH and finding nothing has changed, so you add more and then discover you've added too much.

Avoid using citric acid as this anti-bacterial substance will kill the bacteria in your system. Vinegar is too weak, hydrochloric and sulphuric is too strong so that they could be hard on your fish.

## Location of System

As a reminder from Chapter Two, the location for your garden must be:

- Safe
- Durable
- Clean
- Accessible to electricity
- Open-spaced
- Adequately ventilated
- The right climate
- Sufficiently lit

For some, the idea of an inground aquaponic garden sounds intriguing, but this type of garden can be unsafe for the garden and those associated with it.

## Other Items In Your Tank Explained

Other items are needed for your tank to keep the whole system in balance so your fish can be healthy, safe, and secure. And, being prepared for anything that might arise:

*Gravel* - the whole purpose of an aquaponic garden is to keep plant fertilization as organic as possible. Since gravel collects the bacteria needed to process the waste and keep the fish healthy and generate the nitrates plants use for food, gravel is an excellent addition to a fish tank. The layer of the gravel should not be too deep. The gravel should be the appropriate size for the fish and have rounded edges. Gravel is better than sand because sand is not an excellent substance for water to flow through. Cracked gravel or pea gravel can also be used.

*Duckweed* - is a viable option for a fish tank because it flourishes on fish waste. Duckweed filters the water for the fish. Duckweed contains a lot of protein, so it serves as food for the fish, but, beware, duckweed doubles in volume every two days.

Air pump – your tank will need an air pump to aerate the water and help provide the necessary oxygen for your fish.

Water pump – a water pump is vital as it moves water from the fish tank back to the grow bed and then back to the fish tank.

Thermometer – this helps you know what the tank's current water temperature is.

Light – fish do not like continual light, so, if you use a light, set a timer, so the fish are exposed to light for 8 hours, or less, a day. On the other hand, a light helps you observe the health and overall well-being of your fish.

Filtration system – a media bed system does not need a filtration system because the process creates filtration. Most other systems require a bell siphon. This will be explained more in the biofiltration section.

Heater – if you have tropical fish, you will need a heater as tropical fish

require a water temperature of between 75 and 80 degrees.

Fishnet – it is always helpful to have a fishnet handy in the event your fish need to be moved.

Test kits - there are a variety of test kits, from one that tests all five factors in aquaponics fish tank, namely: pH, High Range pH, Ammonia, Nitrite, and Nitrate. A KH kit is also helpful to have on hand.

Siphon (gravel vacuum) – at times, your gravel might need to be siphoned (vacuumed). There are many inexpensive and simple siphons on the market. Remove any plants, dead plant material, or excess food. If these materials are left on your gravel, a build-up of ammonia could occur. There is no recommended time for siphoning. Most people siphon once a week or once every other week.

Water bucket - a 5-gallon water bucket is helpful to have nearby in case water needs to be added or drained.

## Types Of Fish

Finally, the crowning jewel of every aquaponic fish tank is the fish. And there are a lot of varieties to consider. Some aquaponic gardens raise fish for consumption. If so, consider their endurance, growth rate, and water temperature needs. No matter what fish you desire to grow, the following should be considered:

1. Calculating the fish-to-water density. Not enough fish equals substandard nutrients for your plants. More than enough fish creates not enough oxygen and stresses out your fish. The standard rule, for a beginning aquaponic gardener, is ¼ pound of fish (or less) for each gallon of water in the tank. Any more than this should be left to those with more aquaponic experience.

2. When it comes to fish, each variety has its own needs. Some fish are not appropriate for an aquaponics fish tank. Others are perfect. The proper aquaponic fish should be able to:

    - Adjust to fluctuating oxygen and pH levels, as well as nitrate saturation.

- Resist diseases and parasites.
- Effectively make good use of nutrients.
- Flourish in crowded conditions

3. A few of the most common fish used in an aquaponic fish tank include:

*Tilapia* – Worldwide, tilapia is the most popular for aquaponic fish tanks because they are easy to grow, easy to manage, and resistant to stress-related diseases and parasites. Tilapia can exist in a more densely populated environment because they do not require high-quality water. They reproduce often. The only drawback is that they are tropical fish and need a water temperature from 72 to 82 degrees. This fish is mostly brought in from overseas and should be avoided from China, as they are prone to disease. Five percent of tilapia is grown in the United States and found to be safe.

*Goldfish* – this variety produces a lot of waste, so they are ideal for an aquaponic system. A cousin to carp, they are a popular, non-edible choice for home systems. Easy to obtain, goldfish add a decorative touch to your system —the right choice for beginners. Goldfish are known for needing less food, which makes them less able to provide the amount of waste required for abundant plant growth.

*Koi* – for an ornamental fish, koi are a popular choice. They grow large and are highly successful when it comes to an aquaponic garden because they adapt well to a lot of different conditions. They also live a long life and are easily managed.

*Trout* – a member of the salmon variety, trout require colder water, a high protein diet, and clean water. While rainbow trout are the most popular to grow to sell or eat, they are a bit higher maintenance.

*Catfish* – the beautiful thing about catfish is that they are adaptable to change, including oxygen, pH, and nitrite fluctuations. They are a healthy fish in their ability to resist parasites and disease. Because they live at the lower levels of a fish tank, their food must be of the sinking variety.

*Carp* – the number one benefit of carp is the fact they survive well in a wide range of water temperatures: 39 – 93 degrees. They are highly durable and

low maintenance.

Bass – Largemouth, smallmouth, white, Australian, and hybrid-striped are all good fish to use, especially if you are growing your fish to eat. Bass grow from 2 to 8 inches the first year, then take two years to grow to full length at a full 10 inches. Bass can survive, like carp, in a wide range of temperatures from 55 to 85 degrees. Bass eat a low protein diet will be top eaters in your tank, meaning they prefer food that is suspended at the surface.

Silver perch – from Australia, this fish is fast-growing and does well in high-density environments. While they can survive in water temperatures from 55 to 90 degrees, they prefer warm water.

Barramundi – this variety is an excellent fish for aquaponics because it is tough, like catfish, carp, and bass. They do well in both fresh and saltwater. They quickly reproduce and grow rapidly. They do prefer warm water and are carnivorous when they are small and are known to eat their siblings, which is why purchasing them when they are at least 3 or 4 inches long is a good idea because that amount of maturity can prevent this.

## Fish Food and Feeding

Generally, the size of your plant growing area determines the amount of food to feed your fish with a formula of: for every 10 square feet of media bed the fish will need 3.6 ounces of food

1. Another rule is to feed your fish as much as they will eat within 5 minutes, one to three times per day.
2. Another fact regarding feeding is that an adult fish eats one percent of its body weight per day.
3. A baby fish eats seven percent of its body weight per day.
4. The more you get to know your fish, the more you will know their eating habits.
5. NEVER OVERFEED A FISH!
6. If your fish are not eating, this may be because:

    - the water is too hot or too cold
    - they may be stressed
    - they lack sufficient oxygen
    - they are out of their proper pH zone.

7. Scoop out any unused food after 10 minutes.
8. Small fish eat more protein and oils in a smaller pellet.
9. Bigger fish eat fewer oils, more carbohydrates in a larger pellet.
10. Store food in a cold environment, away from the garden to avoid mold, mildew, and prevent the food from going rancid.

## How Many Fish

When it comes to how many fish you need to support your grow bed, there are a few essential things to consider. The amount of fish is dependent on the plant nutrient needs, which makes sense since the whole reason fish are present is to provide nutrients needed by the plants. In general, fish retain about 80 percent of the food they eat while 20 percent turn into fish waste. Generally, for a beginner, the fish-to-plant ratio is 1:1, tank volume to grow bed volume. Other ways to consider are:

1. One pound of fish for every 5 to 7 gallons of fish tank water
2. Add up the grow bed in square feet.
3. Take the grow bed square footage and using the 1 lb. of fish to 1 square foot of 12” grow bed, figure out the number of fish allowed
4. Using the one pound of fish weight for every 5-7 gallons of water, total up amount of fish tank water needed.

Example:

- You have a 5-pound fish. This tells you that 25 to 35 gallons of water is needed.
- The ratio of fish to media bed being 1:1, this tells you that a 5-pound fish needs 5 square feet of grow bed that is 12” deep (the standard depth)

This tells you that you need:

- One five-pound fish
- 25 to 35 gallons of water
- A media bed that is 5' wide x 5' long x 12" deep

From here, the are other considerations that come into play, when deciding

how many fish are needed to fulfill your plant's needs, are:

- The type of plants you have (because of their nutrient needs)
- The type of fish you desire (and their ability to generate plant nutrients)

Other considerations are:

- Amount of oxygen needed (concerning fish density)
- Water temperature (different fish varieties require different temperatures)
- Type of water (salt or fresh)

Let's look deeper, so you can understand how they all play into the equation:

*Type of plants*- every kind of plant varies in their nutrient needs. Low to medium nutrient need plants are:

_ Basil
_ Cabbage
_ Cauliflower
_ Chives
_ Garlic
_ Herbs
_ Lettuce
_ Onions
_ Peas
_ Spinach

Plants that have higher nutritional needs are:

_ Cucumbers
_ Tomatoes

## Fish Nutritional Variations

Each fish has its nutritional requirements, so, for a beginner, raising fish with equal nutrient needs can make fish management easier.

## Fish Feeding Rates

The fish feeding rate ratio is the amount of food to feed your fish daily, so

they can deliver nutrients to your grow bed plants. Because of this, the number of plants you have determines the amount of food you should feed your fish. The reason for this is because the fish provide the waste –with bacteria turning the waste into nutrients--knowing fish retain 80 percent of their food and excrete 20 percent. The general feed rate ratio for leafy vegetables is 20 to 50 grams of food per 10.7 square feet. The feed ratio for fruiting plants is 50 to 80 grams per 10.7 square feet.

The formula above that showed how many fish per gallons of tank water and media square footage could also be used to determine how much food to feed your fish:

One five-pound fish = 25 to 35 gallons of water = a media bed that is 25 square feet (5’ wide x 5’ long x 12”) deep = 40 to 100 grams of food.

## Amount Of Oxygen

The oxygen level in the water should be tested to make sure your fish are getting enough. An oxygen meter is helpful and can be purchased online for as little as $10.00. The plants in your water release oxygen to your fish and allow aerobic bacteria to break down nutrients. For regular fish, 4-5mg/liter of dissolved oxygen is adequate. Salmon and trout typically function best with 8mg/liters, which is why it is essential to pay attention to oxygen variations when choosing which type of fish to grow. Reasons for low oxygen are:

- Too much water in the tank
- Too many fish
- Algae
- Jammed filter
- Temperature issues

Signs to look for include gasping fish or that they gather at the filter opening. Small fish use more oxygen than larger fish.

How to correct this:

1. Add a pump with an air stone if you don’t have one already.
2. Purchase a filter with a waterfall.
3. Add more oxygen-generating plants to your fish tank.
4. Cut down the number of fish in your tank.

5. Correct the water temperature issue.
6. Clean the filter.
7. Remove the algae.

## Type of water

Some fish live in saltwater while others live in freshwater.

## Adding Water

When it comes time to add water to your fish tank, testing your water is a must because then you an idea of what it's in it and how it might affect your fish as far as chlorine and chloramine are concerned. If your water has chlorine in it, the chlorine must be removed before the fish are added. The chlorine level should be 1 part per million (ppm). If you are using tap water, add 1/8th of a teaspoon of Vitamin C for every 20 gallons of water to eliminate the chlorine and chloramine. Also, test the pH. This should be in the 6.8 – 7.4 range. Purchasing a water purification system can do the trick or letting the water sit for at least 24 hours or even aerating your system. When it comes to any changes with your water, pH, temperature, chlorine, etc., just remember to make small adjustments. Significant changes can stress out everything in your system.

When filling the tank, to not disturb the objects in the tank, put a bowl at the bottom. Put the nozzle in the bowl and turn the water on to a soft flow. Make sure to rinse all the items that are going into your fish tank. Fill the tank to 95% of capacity. If splashing is occurring, adjust the flow rate on the pump. In a new system, water should be tested daily. A more mature system can be checked once a week. Keeping a journal regarding changes in your system is a good idea because you will forget.

Other things to remember about the water in your system:

- A new system may need to have water added as evaporation takes place. Older systems need water added, but not as much.
- Adding additional water to your grow bed is easier on your system than adding water to the fish tank.
- Adding water to your grow bed also delays any issues that might arise. This allows time to fix any problems before the fish become involved.

- Never add or remove more than 1/3 of the water in your system at one time. Instead, add, or remove, 1/3 water in the morning and the other 1/3 at night.
- The ideal flow speed for your water is when it ripples but does not splash.

## Monitoring Fish Health

Like humans, fish are vulnerable to illness and disease. Fortunately, some signs signal that something isn't quite right:

- Changes in their gills--rapid movement, for instance
- Noticeable changes in their swimming patterns--hovering at the surface, hiding, rubbing against objects in the tank
- Enlarged or concave stomach
- Infection in the head or on the mouth
- Cloudy or swollen eyes
- Frayed fins
- Light gray small spots
- Sores, growths, or color changes in skin

An ounce of prevention is worth a pound of cure when it comes to your fish, as well. Preventative measures include:

- Making sure gravel is clean
- Screening all new fish added for disease
- Making sure the fish are compatible
- Having enough hiding places
- Not over-feeding
- Not over-stocking
- Always having high-quality water
- Making sure metal or copper are not present in the system (metal and copper are deadly to fish)
- Never having sharp objects in the tank

## Solids Removal

Filtering is not needed in media beds because fish waste and uneaten foods are naturally broken down into the system. A filtration system is required to

eliminate fish waste and uneaten food for Deep Water Cleaning, Raft, Floating, and Nutrient Film Technique and practically every other system. This is because waste quickly changes into toxic waste for your fish. Waste is also known for clogging the filters of your tanks and the flow of water.

## Adding New Fish

For new fish added to a new aquaponic system, this was discussed in Chapter Two, in the steps of setting up your fish tank, so the details of this will not be repeated. A few things to remember are:

When adding new fish, great care must be given as fish are sensitive to changes in:

- temperature
- oxygen
- pH
- ammonia/nitrates/nitrites
- heat
- cold

Quarantine any new fish for 3 to 5 days to make sure they do not have any diseases that could spread to your existing fish. The same approach is then given to adding fish to an aquaponic system as a traditional aquarium:

- Float the bag of fish in the system water so temperatures will match (usually 30 to 35 minutes)
- Open bag
- Add a few cups of water from the fish tank to the bag so fish can adjust to pH.
- After 20 more minutes, release fish into the tank from the bag.

## Fish Harvesting

For those who are raising fish to eat or sell, the process for harvesting them is simple:

1. Don't feed fish for three to five days.
2. Turn off flow valves.
3. Drain water.

4. Make sure to save water.
5. Have a container with clear, clean, icy water (to “dispatch” fish quickly).
6. Use nets to corral fish or wear waders and get in the water to collect the fish.
7. Throw the fish into ice water to dispatch them quickly.
8. Clean the fish.
9. Seal them in plastic.
10. Store them on ice or in the freezer.

## Fish Troubleshooting

- Diseased fish - remove from the tank immediately to avoid spreading. A salt bath can be used to treat sick fish. Use a 30-minute bath with a high concentration of saltwater. Fish should be destroyed if no improvement is shown within ten days. For fish that show improvement, re-introduce them gradually to the tank.
- Moving Fish – float plastic bag containing fish in current tank water. Move the plastic bag to a new tank for 15 to 20 minutes. You can match water temperatures between the old and new tanks as well and transfer the fish from the past to the new tank.
- Avoid these life-threatening issues:

✓ Unintentional Poisoning
✓ Introducing Fish Before Tank is Ready
✓ Too Many Fish
✓ Trusting Fish/Pet Stores
✓ Having Too Small of a Tank
✓ Continually Moving Objects in Tank
✓ Lack of Enough Knowledge on Freshwater and Saltwater Tanks
✓ Not Enough Water Changes
✓ No Biological Filtration
✓ Keeping the Wrong Fish Together
✓ Negligent Maintenance of Tank
✓ Not Testing the Water Enough
✓ Not Getting Rid of Algae
✓ Lack of Understanding of the Nitrogen Cycle

✓ Not Using Life Plants
✓ Overfeeding Fish

## Chapter Three Checklist

- The first step in any aquaponic garden is the fish system.
- A variety of different types of materials can be used.
- The top of the fish tank/container should be as wide as possible.
- Larger tanks are better than smaller tanks.
- An average aquaponic fish tank usually holds 300 gallons of water.
- Water should cycle through your system up to one time per hour or 24 times per day.
- Water dichlorination takes between 4 to 6 weeks of cycling the water before fish are added.
- Fish tank must be covered, so fish do not jump out.
- The target pH balance of an aquaponic fish tank is 7.0.
- The pH should be tested 3 to 4 times weekly.
- Location must be durable, clean, accessible to electricity, open-spaced, adequately ventilated. the right climate and sufficiently lit
- Tank needs gravel, air pump, water pump, thermometer, light, filtration system.
- Calculating the fish-to-water density is a must.
- When it comes to fish, all varieties do not suit one tank.
- The size of your plant growing area determines the amount of food to feed your fish.
- The amount of fish is dependent on the plant nutrient needs
- The feeding rate ratio is the amount of food to feed your fish daily, so they can deliver nutrients to your grow bed plants.
- The oxygen level in the water should be tested to make sure the fish are getting enough.
- When it comes time to adding water to your fish tank, test your water first
- Like humans, fish are vulnerable to illness and disease.
- Be careful when transporting fish.

# Chapter Four: Aquaponic System Setup

Because of the versatility of an aquaponic garden, every system is different from the next. Some general directions for setting up each system follow. To get a brief overview of each system, it is sometimes helpful to look at videos on the internet that show some versatility and the nuances. While videos are useful, they lack the depth needed to understand all the dynamics behind an aquaponic system.

## How to Set Up A Sun Pond Aquaponics System

The sun pond is as close as one can get to the original aquaponics system set up by the Aztecs. This simple setup is simply a fishpond or container where the plants float with the roots beneath the water. Setting one up is basic:

1. Make sure you do not need a permit.
2. Decide on the size of the pond – big yards have ponds that run 8 feet deep, deep enough that fish can find relief from sunlight.
3. Decide location-- not in direct sunlight (keep in mind air temperature and its impact on the pond--stay away from trees and plants that might be harmful to fish.
4. Dig pond – standard depth is four feet and can run as deep as 8 feet.
5. Line pond – never use cement as cement kills fish.
6. Add pump - for circulation, like a Solariver Solar Water Pump Kit of Beckett Corporation Solar Air Pump.
7. Install water filter – not all ponds need a filter, particularly those that are not planning on growing fish or have just a few fish.
8. Add rocks – make sure stones do not contain limestone.
9. Add fish - koi is an excellent sun pond fish.
10. Add plants – water lilies and water hyacinth work well for shade.

## How to Set Up A Media Bed Aquaponic System

Since the Media Bed System was used as an example of how to set up an aquaponic system in Chapter Two, those steps will stand.

## How To Set Up A One Barrel Aquaponics System

The aquaponic garden is all contained into one barrel with the fish tank at the bottom. The top is flipped to create the media bed. Always make sure the barrel has never stored anything toxic. The setup is the same as the media bed, using the same substances, only instead of having an aquarium and a framed in bed; both systems are contained in this one barrel.

Directions for a One-barrel Fish Tank:

Materials Needed:

One- 55-gallon barrel
One water pump
Media for the grow bed, like expanded clay pellets
½" piping to go from the water pump to the grow bed and the bell-siphon to the fish tank
2 - #18 o-rings
2 - #14 o-rings
Hacksaw or PVC cutter
Fish-approved silicone

1. Check barrel to make sure it is safe for your fish.
2. Examine the barrel valve. Make sure there is an adequate seal on the barrel valve, so there are no leaks. If included, take out the pressure relief part of the valve and replace this part by sealing it with fish-grade silicone.
3. Cut the barrel 7.5" from the top. This is for the grow bed. Clean up the rough edge so that it is smooth.
4. For a front view into your barrel, cut an oblong circle about the size of a dinner plate, 2" from the top of the bottom fish container. The front viewing point should be big enough for you to work with the inside of the tank, but not so big that it takes away from the fish water line. Cut a circle on the opposite side for access into the backside of the fish container.
5. Drill 2 holes in the bottom of grow bed: One needs to fit a 20 mm or ¾ " tank or bulkhead fitting and far enough away from the side of the grow bed so that a 90 mm media guard made from a stone water pipe can be placed over it.
6. The other hole needs to be wide enough to fit a 20 mm or ¾" wide

PVC fitting with a thread on the end that allows for another fitting to thread onto this underneath the grow bed. An O-ring should be on the fitting to make sure that it seals tight. Place the PVC fitting onto the hole inside the media bed and twist it through the hole in preparation for adding the fitting underneath.

7. Drill 6 holes evenly spaced around the bottom lip of the grow bed and the top of the fish tank. Match up the six holes, then thread a zip tie through each one so the grow bed is not fastened to the fish tank.
8. Take the 200 gallons per hour water pump to run the water from the fish tank to the grow bed. Add a flexible aquarium-grade pipe (an irrigation hose is fine as long as it doesn't kink). This will serve as the source for running water from the water pump to the grow bed. This pipe should run from the water pump, at the bottom of the fish tank, to a height of 2" above the opening of the fish tank. Add a ¾" Hydro Flow Barbed Tee to the upper end of pipe or hose ( heat hose to fit). Add about 2" of the hose onto the barb protruding from the tee-pipe, then add one Hydro Flow Premium Barbed Ball Valve (to spray water onto the top of fish water).
9. At the top end of the pipe or hose, above the valve, add an adapter from hose bib to the PVC pipe. Place the water pump and piping (with tee-pipe, Barbed Ball Valve, and adapter) on the bottom of the fish tank. Screw the PVC reducer into the bottom of the media bed and then underneath the media bed, screw in the pump hose adapter (with a hose attached) into the PVC adapter. Once this is done, On the top of the PVC adapter, fit in an 8" piece of PVC pipe. Glue in place. Put a tee-pipe on top of the 8" PVC pipe, so water can flow out from the fish tank into the tee-pipe and have two exits for increased aeration and water movement.
10. Make a Bell Siphon for the water to exit back into the fish tank:

Bell Siphon For Grow Bed:

Three main pieces comprise bell siphon:

A. A shroud with holes that keeps media from going to siphon

B. A bell with a reservoir that fills with filtered water
C. A standpipe that delivers water out of the grow bed into a reservoir

To Make the Shroud:

1. Cut slits into 4" storm pipe, ¾" away from the bottom.
2. Allow room for the drain cap.
3. Cut nine slits allowing ¼" between them.
4. Make three rows of 9 slits, and then four rows of 4 slits above those.
5. Sand smooth where needed.
6. At the bottom of the shroud, the drain holes should be no larger than the smallest rocks or pellets in the grow bed. Put bottom cap on with two screws.
7. Drill holes around the pipe and cap.
8. The top cap must be loose enough to remove.

To Make the Standpipe:

1. Add a 5/6” reducer onto a ¾” pipe so large amounts of water can enter.
2. Attach the pipe to a ¾” adapter bush so pipe and attachments can fit into a 5/6” valve socket.
3. Connect pipe to 5/6” bulkhead fitting by attaching valve socket to fitting.
4. Attach standpipe to an elbow pipe, so water flow is directed appropriately by a one ¾ to 1" uniseal. Make sure this is watertight.

Building the Bell:

1. After measuring the length of your standpipe, add two inches.
2. Cut 2 ½ “ pipe the length you just measured. This is the bell.
3. Glue on an end cap, making sure the pipe and cap are tight.
4. Apply a coat of glue to the pipe and cap.
5. Hold the cap in place for 15 seconds.
6. Make cuts, like the shroud, on the bottom of your bell pipe.
7. Cut out 3 ½” pieces from the pipe.

Installing the Bell Siphon System:

1. Decide where you would like your bell siphon to go (should not be close to an edge) and drill a one ¼" hole for the bulkhead piece.
2. Place a washer and then end cap on top of the drilled hole.
3. Place the bulkhead in the hole and add a washer underneath.
4. Tighten the nut with pliers.
5. Screw an elbow pipe underneath the base.
6. Add another pipe to this to direct water flow into the fish container.
7. Fill the fish tank with water that is 95% of the way from the opening of the container.
8. Add media to grow bed, like expanded clay pellets that have been through a vinegar test, checking for limestone (put a handful into a cup of vinegar and see if it fizzes. If so, don't use). Wash media thoroughly before placing it in the tank.
9. Plugin the water pump. Make sure the water is pumping from the fish tank into the grow bed, then draining back down into the fish tank. Make sure to adjust the flow so it trickles in and out slowly. Plugin the air stone so that bubbles can provide fresh air.
10. Check for leaks and repair them. Then, test the pH balance of your water using litmus paper, a test kit, or pH meter. The water should be at 7.0 pH. If it is lower than 6.8, add "pH up." If it is higher than 7.2, add "pH down."
11. Your system should now rest for 24 hours. This allows for any chlorine to be removed and for bacteria to start to grow.
12. Twenty-four hours from the completion of your system setup, add your fish. Begin by adding ½" of fish per gallon of water. Four weeks after the introduction of your fish, the density can be increased to 1" of fish per gallon of water.
13. Ideally, you should wait approximately four weeks to add plants to your system, but if you are eager to plant them, a few plants or seeds can be added. Then, increase plant density in a month, or so, when your system is well established.
14. If needed, heating the water to the right temperature can

be expensive. When heating fish tank water, consider insulation or putting system close to house or building (to slow down the heat).

## How To Setup A Two-Barrel Aquaponic System

This system uses two blue 55-gallon barrels. Use one for the fish tank and the other for the media bed or cut the barrels in half lengthwise. Use one-half for the media bed and the other half for the fish container. The specific setup is the same as the one-barrel system and media bed system.

## How To Setup A Vertical Rack Aquaponic System

Directions: (more towers can be made by repeating the directions for each tower you build).

Materials needed:

- 4-in. diameter, 10-feet long PVC pipe or another type of pipe of your choosing
- 24 - 4" net cups (you can cut more holes and have more net cups if you like)
- Self-Watering Wick Cord
- 1 – 5.25’ strip of cloth (to place inside vertical rack pipe for roots to attach to
- 1 - scrap wood
- rolls electrical tape
- One – water pump: The pump should circulate all the water in your system at least every two hours, which means half the water every hour. If you have 200 gallons of water in your system, you will need a pump that circulates 100 gallons per hour so that you will need a pump with 100 GPH.
- 10 feet of tubing to go from pump to top of the tower
- One – air pump: this is optional as system aerates on its own, but more system can produce better with an air pump
- Saw to cut pipe
- Drill to 3/16 drill hole
- Plants with shallow roots
- Five-gallon container
- Round opening for top of 5-gallon container with lid

- Silver marker for marking cuts or slits
- Measuring tape to measure marking cuts
- Metal file for sanding

Directions for Making Vertical Rack Tower:

1. Take a 4” diameter PVC drainpipe that is 10 feet long.
2. Cut the pipe in half so that you have two 5-footlong pipes.
3. Make eight slots along the length of the 5’ pipe (about 7 inches apart with 4” left to attach the wick to pipe)
4. Cut into each cut (or slit) about a half-inch deep.
5. Heat pipe on the top portion of the slit with a mini blow torch.
6. Make a circular wooden wedge to inset into the hot area above slit that's just been cut (inserting the neck of a small champagne bottle work too).
7. While pipe, above cut, is hot, push bottle, or wedge, into pipe above the cut.
8. Keep wedge in there until pipe cools.
9. Take out a bottle or wedge.

--another way to create vertical rack is to use wye tee (Y) PVC pipes. Connect wye-tee pipes with wye-tee connectors, making sure each of the openings of wye pipes are facing different directions. With this system, the water reaching the roots is a little more difficult because the wye-tee pipe has a slanted opening, so net pot sits more on the outside of the 4” pipe rather than sitting in the indented hole of the vertical rack.

--another alternative is to use the same wye-tee pipes and five 10” pieces of PVC pipe. Connect a wye-tee pipe with a 10” PVC pipe and continue doing this until you have the height of vertical rack you’d like. Same difficult water--to-plant access exists with this form of vertical rack as well.

10. About ½" above the edge of the upper slit that is indented, drill a hole for wicking to go through so it can collect water for the net pot.

Bucket Base:

1. To hold up the vertical pipe, take a five-gallon bucket and lid.
2. Cut a hole in the lid. This should be the size of your vertical pipe (4”). The tower pipe will be inserted into this.
3. Up high on the side of the five-gallon bucket, near the lid, drill a hole for the water pump tubing to exit bucket.
4. About ¼ of the way around the bucket, the same height as the hole for the pump, drill a hole for the air stone.
5. Create an access hole with a lid, in the bucket lid, so you can feed the fish, check on the fish, etc. rather than taking the lid off each time.
6. Put the vertical rack tower into the hole in the bucket.
7. Attach a tube from the water pump located at the bottom of the bucket base. The tube can run up the side of the rack and drip into the tower. A-frame can be built with a top portion where the tube runs across the top with holes where the water drips into the tower. The wick helps support the water’s ability to feed the plants.
8. Several of these buckets can be made and added together. The fish tank base is set up the same way as a media bed fish tank with gravel, water pump and air pump and air stone.

Wooden Base for Multiple Towers:

1. Decide how many vertical towers you would like to have. (Remember, for the simplicity needed in a book, instructions were only given for only one vertical rack, so multiply the number of towers you'd like and then make the same amount of holes in the tower base to hold up each of your vertical rack towers.)
2. For each tower, you decide to build, drill a 4" hole in a 4" wide PVC pipe, the length of which you choose as you determine how many vertical towers you would like to have supported by this base. Do not put the vertical rack towers in yet.
3. Brace this pipe with pipe brackets screwed onto a board that is wide enough and thick enough to support the weight of your towers. If you have too many towers, secure the top by attaching the top of your vertical rack towers to a horizontal pipe. A frame of PVC can be used to "frame" in your towers, or the top horizontal PVC pipe can be suspended from the ceiling.
4. Fit one vertical rack into the horizontal pipe.

5. Take a straight connector pipe, drill a 1/2” hole in it that is centered between the top and bottom of the pipe. A tube will be inserted into this whole and bring fish water in from a bigger, fish water-filled pipe above, should you desire to push water through a top pipe with one tube, or pipe, instead of having a tube going into each tower).
6. Put a PVC elbow pipe on the top of each vertical rack.
7. PUT A 4” NET POT INTO EACH HORIZONTAL TREE HOLE.
8. A PIECE OF 1" PVC PIPE CAN THEN BE CUT AND INSERT INTO 1" HOLE AT THE LOWER END OF PIPE FOR WATER TO DRAIN INTO 5-GALLON BUCKET (FOR BUCKET BASE)
9. Cut strips of material and attach them to the tops of the vertical pipes. Drape them into the pipe's, so that the roots can connect to them.
10. Follow the directions for the media bed fish tank.
11. Decide where you would like your fish tank or container to go.
12. Aquarium tubing will need to be attached to the water pump.
13. There should be a pump adapter to fit a 1” diameter tube.
14. Feed the tube up the tower.
15. You may need to split the tube by using adapters so that the water can flow to the top of each tower. A 4-way splitter can help the water flow more evenly.
16. Each tower should have a drain tube that goes back into the fish tank through a plastic gutter or other means.

Things to Know About Your Vertical Garden Towers:

1. It is essential to pay attention to the covering of the bucket to prevent sunlight from getting into the water to avoid algae growth and other problems.
2. Make sure you know the full weight of each of your pipes so that all pipes are of equal weight.
3. Consider the wind and do what it takes to make sure they are secure.
4. Angle your towers slightly to help make sure the water flows to

where the drainage hole is, so the water gets returned to the tank. (This is for multiple towers with a gutter catch.)
5. The plants need to grow in something like Rockwool or pond filter foam.

## How To Make An IBC Tote Aquaponic System

Directions:

Materials needed:

- IBC container
- Water
- Air pump
- Airstone
- Enough tubing to connect the air pump to the air stone
- Drill with bits
- Electrical tape
- 4" Plastic Water Pump Replacement Strainer
- Fish
- Grow container
- Growing medium
- Plants
- pH test kit, pH down and pH up
- Scissors
- Tools

Directions: USE PROTECTIVE GEAR – SAFETY GLASSES, EARMUFFS, GLOVES, LONG PANTS, AND LONG-SLEEVED SHIRT

Creating Media Bed and Fish Container from IBC container:

1. Using a Phillips screwdriver, remove top bars of the container.
2. Remove the plastic container from caging.
3. Flip plastic inside the frame, so the top is at the bottom.
4. Drainage is now used to drain.
5. Measure 8 inches up from bottom pallet, (bottom rung is seven inches from the pallet, so one inch above bottom rung), follow 8" line around the container.

6. Beginning on one of the sides of the marked container, cut container (cut corners last so the container will be easier to handle).
7. Container is now cut into two pieces: a smaller portion for the grow bed, a more substantial part for the fish container.
8. Now take the caging structure, turn cage upright, so the pallet portion is on the bottom.
9. Cut vertical supports just above the first rung.
10. After the first vertical rung is cut, cut above the first rung around the cage, so the cage now has a significant portion to support the fish container and a small portion (pallet portion) to support the grow bed.
11. Sand cut ends, then spray with anti-rust paint.
12. Turn large cage portion over so the cut pieces are on the floor. If you are worried about flooring, put cut pieces on wooden planks.
13. Use an aquarium-grade sealant to fill in any gaps around the pressure release valve, under the grow bed.
14. Place the fish container on top of the cage pallet portion without legs. The tank must be level. Dig a small hole under valve opening. This will allow proper draining in the event of a leak. Place the cage over the fish tank. Then, attach the valve cover with zip ties.
15. Place two pieces of wood on top of the fish container structure. Wood pieces should be longer than the fish container structure cage. Place the grow bed on top of the wood. Grow bed should be one foot back from the opening of the fish tank. Screw two top bars from the cage back in the openings on the grow bed cage. Place the grow bed in its cage.
16. Drill 2 holes in the bottom of grow bed: One needs to fit a 20 mm or ¾ “ tank or bulkhead fitting and far enough away from the side of the grow bed so that a 90 mm media guard made from a stone water pipe can be placed over it.
17. The other hole needs to be wide enough to fit a 20 mm or ¾” wide PVC fitting with a thread on the end that allows for another fitting to thread onto this underneath the grow bed. An O-ring should be on the fitting to make sure that it seals tight. Place

the PVC fitting onto the hole inside the media bed and twist it through the hole in preparation for adding the fitting underneath.

18. Take the 200 gallons per hour water pump to run the water from the fish tank to the grow bed. Add a flexible aquarium-grade pipe (an irrigation hose is fine as long as it doesn't kink). This will serve as the source for running water from the water pump to the grow bed. This pipe should run from the water pump at the bottom of the fish tank to the grow bed—valve (to spray water onto the top of the fish water).

19. At the top end of the pipe or hose, above the valve, add an adapter from hose bib to the PVC pipe. Place the water pump and piping (with tee-pipe, Barbed Ball Valve, and adapter) on the bottom of the fish tank. Screw the PVC reducer into the bottom of the media bed and then underneath the media bed, screw in the pump hose adapter (with a hose attached) into the PVC adapter. Once this is done, On the top of the PVC adapter, fit in an 8" piece of PVC pipe. Glue in place. Put a tee-pipe on top of the 8" PVC pipe, so water can flow out from the fish tank into the tee-pipe and have two exits for increased aeration and water movement.

Make a Bell Siphon for the water to exit back into the fish tank:

Bell Siphon For Grow Bed:

Three main pieces comprise bell siphon:

- A shroud with holes that keeps media from going to siphon
- A bell with a reservoir that fills with filtered water
- A standpipe that delivers water out of the grow bed into a reservoir

To Make the Shroud:

1. Cut slits into 4" storm pipe, ¾" away from the bottom.
2. Allow room for the drain cap.
3. Cut nine slits allowing ¼" between them.
4. Make three rows of 9 slits, and then four rows of 4 slits above those.
5. Sand smooth where needed.
6. At the bottom of the shroud, the drain holes should be no larger

than the smallest rocks or pellets in the grow bed. Put bottom cap on with two screws.
7. Drill holes around the pipe and cap.
8. The top cap must be loose enough to remove.

To Make the Standpipe:

1. Add a 5/6” reducer onto a ¾” pipe so large amounts of water can enter.
2. Attach the pipe to a ¾” adapter bush so pipe and attachments can fit into a 5/6” valve socket.
3. Connect pipe to 5/6” bulkhead fitting by attaching valve socket to fitting.
4. Attach standpipe to an elbow pipe, so water flow is directed appropriately by a one ¾ to 1" uniseal. Make sure this is watertight.

Building the Bell:

1. After measuring the length of your standpipe, add two inches.
2. Cut 2 ½ “ pipe the length you just measured. This is the bell.
3. Glue on an end cap, making sure the pipe and cap are tight.
4. Apply a coat of glue to the pipe and cap.
5. Hold the cap in place for 15 seconds.
6. Make cuts, like the shroud, on the bottom of your bell pipe.
7. Cut out 3 ½” pieces from the pipe.

Installing the Bell Siphon System:

1. Decide where you would like your bell siphon to go (should not be close to an edge) and drill a one ¼" hole for the bulkhead piece. Place a washer and then end cap on top of the drilled hole.
2. Place the bulkhead in the hole and add a washer underneath.
3. Tighten the nut with pliers.
4. Screw an elbow pipe underneath the base.
5. Add another pipe to this to direct water flow into the fish container.

Fish Container:

1. Fill the fish tank with water that is 95% of the way from the opening of the container.
2. Add media to grow bed, like expanded clay pellets that have been through a vinegar test, checking for limestone (put a handful into a cup of vinegar and see if it fizzes. If so, don't use). Wash media thoroughly before placing it in the tank.
3. Plugin the water pump. Make sure the water is pumping from the fish tank into the grow bed, then draining back down into the fish tank. Make sure to adjust the flow so it trickles in and out slowly. Plugin the air stone so that bubbles can provide fresh air.
4. Check for leaks and repair them. Then, test the pH balance of your water using litmus paper, a test kit, or pH meter. The water should be at 7.0 pH. If it is lower than 6.8, add "pH up." If it is higher than 7.2, add "pH down."
5. Your system should now rest for 24 hours. This allows for any chlorine to be removed and for bacteria to start to grow.
6. Twenty-four hours from the completion of your system setup, add your fish. Begin by adding ½" of fish per gallon of water. Four weeks after the introduction of your fish, the density can be increased to 1" of fish per gallon of water.
7. Ideally, you should wait approximately four weeks to add plants to your system, but if you are eager to plant them, a few plants or seeds can be added. Then, increase plant density in a month, or so, when your system is well established.
8. If needed, heating the water to the right temperature can be expensive. When heating fish tank water, consider insulation or putting system close to house or building (to slow down the heat).

## How To Make A Deep Water Container/Raft Method/Floating Aquaponic System

With this system, every plant gets its own grow bed. This system is mainly used for vine plants. Plants are supported by a floating platform, like a Styrofoam raft, with the roots dangling in the fish water. An air pump provides aeration. High amounts of oxygen and nutrients are the benefit of this system.

Generally, the depth of the container is 12 inches for plant roots. Closed-cell

polystyrene insulation boards work well as a flotation device—spacing plants eight inches apart well. An air stone is used for increased oxygenation. Start seeds in media cubes or net pots, then add them to the system.

Nitrifying microbes are a vital part of this aquaponic system, so rafts should be washed with water to remove algae and debris, but not dried.

Any kind of heavy plastic container, even a plastic bin with a lid can work, the lid being used as the “floatation” with the tub holding the water underneath.

Materials Needed:

- Container (tote, bin) with lid (will be used to hold net pots/plants – one that is food safe, made of polypropylene is safe for outside (has a rating of 2 or 4) or inside (has a 5 rating)
- Biofilter, as explained on page 25
- Fish tank water large enough to circulate the volume of water for your system
- Air pump
- Airstone
- Tubing for air pump to airstone, from the fish tank to biofilter to container
- 2” thick Styrofoam board - this will be the flotation device
- 3” net pots – these fit into holes drilled into Styrofoam board

Directions:

<u>Water-based Grow Bed:</u>

1. Wash Deep Water Container thoroughly Add nutrients to water (Masterblend, 4-18-38), 2.4 g Masterblend, 1.2 g Epsom Salt, 2.4 g Calcium Nitrate per gallon of warm water. Test pH. 6.0 is best.
2. Drill a hole high up, centered, on one side of the container for biofilter tube
3. A hole should be drilled on the opposite side of the container, centered, low down for drainage back into the fish tank.
4. Drill 3" holes, 10" apart.
5. Place an air pump outside of the system with the air stone inside.

6. Plant seeds in Rockwool, surround in expanded clay pebbles to hold Rockwool in place and keep out of sunlight.
7. Lights should be as close to plants as possible.

## Biofilter

This filtration system is vital for water-based systems. Fortunately, setting up the system is simple. It mainly consists of a tank or container that is connected to some form of aeration. The tank includes a system of filters that provide an area for bacteria to grow that are needed to turn the ammonia into nitrites and then nitrates to feed your plants.
The biofiltration process has three main parts:

- An air pump that pushes the fish water out of the fish tank and into the biofilter container or tank
- The fish water then goes through the biofilter to change the toxic ammonia into nitrites and then nitrates to feed the plants
- The new plant-healthy water is then sent onto the grow bed to feed the plants.

Some water-based systems use gravity to bring the water from the fish tank to the biofilter. And, because bacteria need oxygen to live and grow, aeration is vital to the biofiltration process.

Purchasing a biofilter is an option, but those that are homemade can be superior to store-purchased ones because of their ability to be customized precisely to meet your system's needs.
Things you need to know about biofiltration:

- Ideal temperature is 63-93 degrees Fahrenheit
- Optimum pH is 7.0 to 9.0
- Biofilters overall condition of effectiveness is checked by monitoring ammonia and nitrate levels routinely
- Optimum level for dissolved oxygen (DO) is 4 to 8mg/liter
- Protection from the sunlight is a must as bacteria is sensitive to ultraviolet light, at least until the biofilm is mature

The concept behind a biofilter is that nitrification can happen on every surface of the system water contacts. The biofilter tank makes this happen. Both the clarifier and the biofilter tank should hold 15 to 20 percent of the

fish water in the tank.

For the biofilter tank to work correctly, it needs two things:

- A surface media that has a surface area high enough for the colonization of nitrifying bacteria
- For the bacteria to have sufficient aeration

Commercially sold biofilter media works, but other materials can be used, such as:

- Material used for packaging
- Lava rock
- Bottle caps made of plastic

The most important thing is that the media is free from any chemicals or substances that would harm your system, so some effort should go into making sure you know the history behind the container you choose. The container should be able to be easily cleaned using de-chlorinated water and not weigh very much. Again, aeration is vital. This is because the microbes that transplant the media need an oxygenated environment to thrive. The ideal dissolved oxygen level for the biofilter tank is five ppm. Sporadically mixing the media will help secure the efficiency of the media by guaranteeing the water flow does not bypass active surface areas.
Biofilter Process:

1. Water from the fish tank goes into a biofilter tank/container
2. The goal then is for twice as much water to get air exposure (some growers add a T-pipe at the end of the tubing or piping, so the water flows out like a fountain from both sides. This allows aeration to happen at its maximum. This is important for gas exchange, removing carbon dioxide and adding oxygen into the water.
3. A thick screen that fits snug to the wall is set in place.
4. Placing a filter pad
5. Bio balls are added. These are small spheres with open spaces where bacteria can grow, taking ammonia from fish and converting it into nitrite/nitrate.
6. Oxygen is added.
7. Water then flows into the plant system before returning to the fish tank.

Directions for fish container:

1. Tote, or container, serves as a fish container:

a) fill the bottom of the container with gravel.
b) attach the air pump to the air stone with the tubing and place it in the tank.
c) place a water pump on the bottom of the aquarium
d) add a tube enough to reach the hole near the top of the grow bed when it is placed on top of the fish tank. Do not plug in pumps.

2. Take the tops of the barrel that you have cut off and:

a) drill a hole, on one of the sides of the container, near the bottom, but one-inch away from where the edge of the bottom meets the edge of the sidewall (see diagram below).
Put a sturdy tubing through the hole with 1" inside the container and the rest long enough, so the water can flow from the grow bed container to the fish tank. Glue in place.

3. At the opposite end of the container, make a ½" hole near the top, centered in the middle. This is for the water to go from the fish tank into the grow bed. Put a tube in the hole and let the tube hang on the outside in preparation for putting into the fish tank. Cover the drain with a 2" Plastic Water Pump Replacement Strainer.
4. The grow bed is built on a platform that is set at a slight angle. Take the tube that's attached to the drain and place the open end of the tube into the fish tank. This is how the water drains from the grow bed back into the fish tank.
5. Fill the tank with water that is 95% of the way from the top of the container. Add gravel. Plugin the water pump. Make sure the water is pumping from the fish tank into the grow bed, then draining back down into the fish tank. Make sure to adjust the flow so that it trickles at a steady stream. Plugin the air stone so that bubbles can provide fresh air.
6. Check for leaks and repair them. Then, test the pH balance of your water using litmus paper, a test kit, or pH meter. The water should be at 7.0 pH. If it is lower than 6.8, add “pH up.” If it is higher

than 7.2, add “pH down.”

7. Your system should now rest for 24 hours. This allows for any chlorine to be removed and for bacteria to start to grow.
8. Twenty-four hours from the completion of your system setup, your fish can be added. Begin by adding ½" of fish per gallon of water. Four weeks after the introduction of your fish, the density can be increased to 1" of fish per gallon of water.
9. Ideally, you should wait approximately four weeks to add plants to your system. If you are eager to plant them, add a few plants or seeds. Then, when your system is more mature, the plant density can be increased.
10. If needed, heating the water to the right temperature can be expensive. When heating fish tank water, consider insulation or putting system close to house or building (to slow down the heat).

**How To Make A Dutch Bucket Aquaponic System**

Also known as a Bato bucket, these 5-gallon buckets are well-known in Europe and the United States. Benefiting from the fish water exchange, this type of garden is used to provide an individual growing environment for plants. Notice plant containers are filled with the same substances used in a media bed. The steps for this system are like the media bed, in that the fish container is set up, and then the media bed is also set up the same. Instead of using a framed in media bed, this system uses smaller containers with the water pump pushing the fish water through the system, and then back into the tank.

Directions:

1. The fish tank is the container on the floor on the right:

a) fill the bottom of the container with gravel.
b) place the air pump to the air stone with the tubing and place in the tank.
c) place a water pump on the bottom of aquarium
d) Add a tube long enough to reach the hole near the top of the grow bed when it is placed on top of the fish tank. Do not plug in pumps.

2. Take the three containers (more or less): drill a hole, on one of the sides of the container, near the bottom, but one-inch away from where the edge of the bottom meets the edge of the sidewall (see diagram below). Put a sturdy tubing through the hole with 1" inside the container and the rest of the tubing long enough, so the water can flow from the grow bed container to the fish tank. Glue in place.
3. At the opposite end of the container, on the side, make a ½" hole near the top, centered in the middle. This is for the water to go from the fish tank into the grow bed. Put a tube in the hole and let the tube hang on the outside in preparation for putting into the fish tank.
4. Cover the drain with a 2" Plastic Water Pump Replacement Strainer.
5. The grow beds are set on top of a platform. Take the tube that's attached to the drain and place the open end of the tube into the fish tank. This is how the water drains from the grow bed back into the fish tank.
6. Fill the tank with water that is 95% of the way from the top of the container. Add gravel. Plugin the water pump. Make sure the water is pumping from the fish tank into the grow bed, then draining back down into the fish tank. Make sure to adjust the flow so that it trickles in and out at a slow but steady stream. Plugin the air stone so that bubbles can provide fresh air.
7. Check for leaks and repair them. Then, test the pH balance of your water using litmus paper, a test kit, or pH meter. The water should be at 7.0 pH. If it is lower than 6.8, add "pH up." If it is higher than 7.2, add "pH down."
8. Your system should now rest for 24 hours. This allows for any chlorine to be removed and for bacteria to start to grow.
9. Twenty-four hours from the completion of your system setup, your fish can be added. Begin by adding ½" of fish per gallon of water. Four weeks after the introduction of your fish, the density can be increased to 1" of fish per gallon of water.
10. Ideally, you should wait approximately four weeks to add plants to your system, but if you are eager to plant them, just add a few plants or seeds. Then, as your system matures, you can

add more.

11. If needed, heating the water to the right temperature can be expensive. When heating fish tank water, consider insulation or putting system close to house or building (to slow down the heat).

**How To Make A Nutrient Film Technique (NFT) Aquaponic System**

With this system, an irrigation-type system is used, where shallow fish water is cycled through a narrow, cylinder-type tube, like PVC. The tube, or pipe, has holes drilled in the top. The roots grow through the holes and absorb the water that is so shallow that it is more like a film than a stream.

Directions:

Materials

- 10-foot gutter pipe to be used as the downspout
- 25 to 30-feet ½" black irrigation tubing
- 27-gallon black tote
- 3" hole saw
- 3" net pots
- Drill
- Hacksaw
- Media substance, like expanded clay pellets
- Plants
- Rockwool
- Tape Measure
- Water pump
- Zip Ties

Directions

1. Cut 3" holes in gutter pipe every 6 inches (more or less than as you desire) to hold net pots.
2. Hang the gutter, using large zip ties, from the ceiling or other frame built to suspend the gutter pipe. Make sure the gutter is a few inches taller than the water container.
3. Take some of the tubing and connect it to the pump. The other end

of the tubing can be placed into the gutter. Make sure the gutter is at an ½” per 10-foot angle, so the water pours back into the tank at the other end of the gutter.

4. Put plants, grown in Rockwool, and expanded clay pellets, into net pots.
5. Once the gutter system has been created, it is ready for attaching tubing to the fish tank for the fish wastewater flow.

Directions for Nutrient Film Fish Container:

1. In the fish container:

a) fill the bottom of the container with gravel.
b) place the air pump to the air stone with the tubing and place in the tank.
c) place a water pump on the bottom of the aquarium with a tube long enough to reach the hole near the top of the grow bed when it is placed on top of the fish tank. Do not plug in pumps.

2. Put a sturdy tubing through the hole with 2" inside the container and 1" outside the container. Attach a tubing into the outside end of the tube, so the water can flow from the grow bed container to the fish tank. Glue in place.
3. At the opposite end of the container, on the side, make a ½" hole near the top, centered in the middle. This is for the water to go from the fish tank into the grow bed. Put a tube in the hole and let the tube hang on the outside in preparation for putting into the fish tank. Cover the drain with a 2" Plastic Water Pump Replacement Strainer.
4. Take the tube that's attached to the drain and place the open end of the tube into the fish tank. This is how the water drains from the grow bed back into the fish tank.
5. Fill the tank with water that is 95% of the way from the top of the container. Add gravel. Plugin the water pump. Make sure the water is pumping from the fish tank into the grow bed, then draining back down into the fish tank. Make sure to adjust the flow so that it trickles in and out at a slow but steady stream. Plugin the air stone so that bubbles can provide fresh air.

6. Check for leaks and repair them. Then, test the pH balance of your water using litmus paper, a test kit, or pH meter. The water should be at 7.0 pH. If it is lower than 6.8, add “pH up.” If it is higher than 7.2, add “pH down.”
7. Your system should now rest for 24 hours. This allows for any chlorine to be removed and for bacteria to start to grow.
8. Twenty-four hours from the completion of your system setup, your fish can be added. Begin by adding ½” of fish per gallon of water. Four weeks after the introduction of your fish, the density can be increased to 1” of fish per gallon of water.
9. Ideally, you should wait approximately four weeks to add plants to your system, but if you are eager to plant them, just add a few plants or seeds. Then, when the system matures, more plants can be added.
10. If needed, heating the water to the right temperature can be expensive. When heating fish tank water, consider insulation or putting system close to house or building (to slow down the heat).

## Chapter Four Checklist

- An essential part of any aquaponics system is the media bed.
- The media bed is responsible for nitrifying bacteria.
- A lot of choices are available when it comes to the type of media bed materials you can use: wooden, plastic, 55-gallon drums, fiberglass, and other safe alternatives.
- The media bed needs to be durable enough to handle the weight of the grow bed.
- Use inert materials, meaning material that is chemically inactive and void of any toxins that could damage the system.
- Media bed substances include expanded clay pebbles, river rock free of limestone, plastic bio media, vermiculite, perlite, lava, and porous gravel.
- The media supports the plants while giving them the necessary oxygen and creating a lot of space for bacteria to collect.
- Media Bed Systems are the most popular because they are easy to build and inexpensive.

- A media bed is an excellent choice for a beginner.

# Chapter Five: Water Systems for Plants

There are two ways to cycle water through your aquaponics system:

- Flood and Drain (also referred to as ebb-and-flow)
- Continuous Flow

Here is how each one works:

## Flood and Drain

- Through the use of a water pump located in the fish tank, or container, the fish water is pushed up and into the media bed.
- The fish water fills the media bed until it reaches the desired flood level, determined by the height set in the bell siphon.
- When the bell siphon “trips,” the fish water drains back into the reservoir.
- When the bell siphon is empty, fish water begins to flow back into the media bed with the help of a water pump.
- This usually takes 15 minutes.
- A timer is set to run for 15 minutes on, then 45 minutes off.
- If your bell siphon runs for 15 minutes every hour and you have a 200-gallon tank, you need a water pump that circulates 800 gallons of water per hour.
- You will need to determine how far against gravity, you need to move the water, otherwise known as "the lift.”
- Use the sliding scale listed on the water pump package to see how much power you need.

## Continuous Flow

While Flood and Drain is the preferred form of cycling water, Continuous Flow is another option. This type of water flow is the same as the flood and drain. However, the timer is removed, so the water can continuously cycle through the system. Two of the downsides of this type of cycling are that the pump is in the fish tank, and the plant's roots can become waterlogged as areas of the grow bed can become stagnant.

## Determining the Right Water Pump

Water pumps come in all sizes to meet your specific aquaponic garden's needs. When deciding which water pump is best for your system, the first thing you will want to determine is the Gallons Per Hour (GPH). Nearly every pump has information regarding the GPH. Typically, the water pump should cycle the water through your system one time every hour, so the pump you choose should meet this requirement.
So, if you have 200 gallons of water in your system, you will need a pump that pushes 200 gallons per hour, meaning 200 GPH.

To make sure your pump meets your water cycle needs, you will also need to measure the head height of your fish tank. The head height is the amount of space between your fish tank, and your grow bed. The reason for this is that the larger the headroom, the more energy is required to pump water. Obviously, in setups, where the fish tank and the grow bed are side-by-side, or at the same level or share the same container, have no headroom.

Once the calculation between the GPH and head height is figured out, then the right pump size can be determined. Water pump packages often come with a chart that combines these two for you. By combining the GPH and head height, you will be able to find the best pump to meet your water cycling needs.

## Types of Water

Water is the main artery of every aquaponic system. Water takes up most of the space and must be monitored to make sure it is balanced and healthy for your fish tank and grow bed.

Water has many parts, and each one needs to be understood. In aquaponics, when it comes to water, the following must become very familiar to you:

- Alkalinity should be at least 100 ppm
- Ammonia should be 0.25 ppm or less
- Dissolved Oxygen should be maintained at five ppm or higher
- pH requirement is between 6.8 and 7.2
- Water Temperature should be 65° to 85°F for warm, 55° to 65°F for cold

Other Water Reminders:

- Add water to grow beds rather than the fish tank.
- Cycle water to remove chlorine and chloramine
- Test the water daily in a new system
- Record all water readings in a notebook.
- City water should be checked for chlorine, nitrites, nitrates, bacteria.
- Never remove more than 1/3 total water volume at once. Instead, do $1/6^{th}$ in the morning and $1/6^{th}$ at night.
- Rainwater might contain dangerous substances.

Ways to Resolve Water Issues:

- Purchase a hose device
- Aeration, aeration, aeration
- Run system with just water in it for a couple of days to eliminate chlorine

## Chapter Five Checklist

- There are two ways to cycle water through your system: Flood and Drain, Continuous Flow.
- The right pump is determined by the Gallons Per Hour (GPH)
- The head height between the fish tank and grow must also be considered.
- Add water to grow beds rather than the fish tank.
- Test the water daily in a new system
- Record findings in a notebook
- Never remove more than 1/3 of tank water at a time.
- Rainwater can be dangerous.
- Aeration is a great way to resolve some water issues.

# Chapter Six: Plants

There are many ways to sew your seeds in an aquaponic garden:

## Media Bed Start

Place your seeds in your media bed and spread them out evenly. Larger seeds should be pushed down under the top layer of the media. Some varieties will germinate better than other types, so you'll want to plant more seeds than you need to anticipate that not all the seeds will germinate. Lettuce and chard do well with this process. One advantage is that no harm will come to your plant's roots as can happen while transplanting your plants into your garden.

## Starter Plugs

Using compressed peat or similar organic materials, plant your seeds in a separate media plug. Allow seeds to germinate. Grow plants at least until roots are established, then transplant the entire plug into your media bed. The plugs will eventually disintegrate. If you are transplanting into a water-based system, gently rinse the roots in a bucket of water and transplant them into your system.

## Cuttings

You can create "cuttings" from your existing plants and plant these directly into your grow bed. Basil and mint are great for this type of "cloning." Simply cut from the existing plant and transplant the cut into the existing bed. Rooting compounds can be purchased to help plants grow new roots if needed.

## Store Purchased Starters

You can also purchase plant starts from a store and transplant them as mentioned above.

## A Few Reminders

If two plants' leaves are touching, their roots are already too crowded. Cut back the plant or move it.

Transplanted plants can sometimes experience shock. Be patient with the change they've just made and give them their time to adjust and grow.

Planting marigolds can work as a natural insect repellent for cauliflowers.

## Plants And Their Growth Requirements

Following is a “grow” list for some of the most popular and easy-to-grow plants:

*Bok choy or white cabbage* –

- great for beginners
- fast-growing and easy
- 3 to 5 hours of natural/artificial sunlight per day
- Tolerant of temperature changes, including frost
- Space plants 6 to 12 inches apart
- Is compatible with lettuce, kale, mustard and mint
- Watch for aphids, slugs, and whiteflies. Screens or nets help.
- Keep the temperature consistent to avoid root rot, wilting, or mildew.

*Lettuce* –

- great for beginners
- Nutrient Film Technique or Floating Raft Style works best
- requires up to 18 hours of sunlight every day
- thrives in 60 to 75-degree temperatures
- water temperature should be 70 degrees

*Swiss chard*

- great for beginners
- Vertical Rack System works best
- can tolerate 41-degree Fahrenheit temperature
- space plants 12” apart
- prefers 60 to 75 degree Fahrenheit temperature
- needs full sunlight

*Mint*

- great for beginners
- Nutrient Film Technique works best
- pH requirements - between 6.5 to 7.0.

- likes partial shade
- prefers 65° to 70°F temperature.
- great companion with tomatoes and cabbage
- space 18 to 24 inches apart
- can get out of control

*Peas* -

- flourish in both natural and artificial light
- Vertical Rack or Floating Raft System works best
- prefers full sun exposure
- prefers 70 to 75-degree F temperature
- pH requirement is 5.5 to 7.0

*Basil* –

- great for beginners
- Vertical Rack or Floating Raft System works best
- pH requirement is 6.5 to 7.2
- prefers full sunlight
- Space plants 12” apart

*Cauliflower* –

- could prove difficult for beginners
- Media Bed/IBC Systems works best
- pH requirement is 6 to 6.5
- prefers 66 to 77°F temperature
- needs full sunlight for at least 6 hours
- sunshine and frost-sensitive

*Chives* -

- great for beginners
- Vertical Rack and Floating Raft System work best
- pH requirement is 6.1 to 6.8
- prefers over 12 hours of light per day
- prefers 65 to 80º F temperature

*Kale* –

- great for beginners
- Floating Raft System works best
- prefers 60 to 70°F temperature
- pH requirement is 6 and 7.5;

*Parsley* –

- great for beginners
- Media bed and Vertical Rack systems work best
- pH requirement is 5.5 to 6.0
- prefers 60 to 75º temperature
- prefers full sun for up to 8 hours a day

*Cucumbers* –

- could prove difficult for beginners
- Media Bed System works best
- Prefers full sunlight
- pH requirement 5.5 to 7.0
- prefers 71 to to 78°F temperature

*Tomatoes* –

- could prove difficult for beginners
- Media Bed System works best
- pH requirement is 5.8 to 6.8
- Prefers full sunlight
- prefers 71 to to 78°F temperature
-

Adding your plants to your media bed, as soon as you have started your aquaponic process, is a strong consideration. This allows your plants time to adjust before the fish are added, and the nitrogen cycle begins.

## Chapter Six Checklist

- The ways to sew your seeds in an aquaponic garden include planting directly into the Media Bed, creating starter plugs, using cuttings from existing plants, and store- purchased.
- If two plants' leaves are touching, cut back or move one of the plants.
- Transplanted plants sometimes experience shock. Be patient with the change they've just experienced, given them time to adjust and grow.
- Marigolds can work as a natural insect repellent for cauliflowers.
- Adding plants to your media bed is a strong consideration.
- Adding plants gives your plants time to establish themselves before the fish are added.

# Chapter Seven: Proper Lighting

## Lighting Choices

Aquaponic plants need a lot of sun. If you plan on growing your plants indoors, make sure your plants receive adequate and consistent light. Because of this, basements and garages are great places to build an aquaponic system (they also tend to have the most consistent air temperatures).

Aquaponic plants need to experience the light spectrum. Here's how this works:

Each plant needs to experience Photosynthetic Active Radiation or PAR. The right aquaponic system should provide complete PAR. This means plants use and absorb and need PAR. Your goal should be to shoot for this. What does this mean? It means that different parts of light do different things. For instance, blue lighting is for the green foliage stage, and red is for the fruiting stage.

Once you understand the spectrum, next is understanding the power or energy lights give off. For instance, one lumen is equal to the illumination of one uniform source on a one-square foot surface.

Aquaponic gardens seek to have one excellent light spectrum with lots of lumens providing light for your plants. If the light is sufficient, the light will penetrate from the top of the plant down to the bottom. A great source of light does not lose a lot of power to heat. In an aquaponic garden, stay away from heat as generated by your light.

Then, there is duration, how many hours a day should the lights be on or off? Just like humans, plants need darkness, except for leafy plants like lettuce. Generally, lighting should be on for 16 hours and off for eight. Leafy vegetables will want upwards of 18 to 20 hours per day.

Twenty-five watts per square foot is standard lighting for an aquaponic garden. Fluorescent lighting is the least expensive and most energy-efficient, and they don't carry a lot of heat.

For your garden, make sure you have:

- A full spectrum lighting
- Lighting that does not give off a lot of heat
- Straight tubes work better to light beds

Three types of lighting are most common for an aquaponic garden:

- Fluorescent Grow Lights – inexpensive but only useful for low-profile plants, like lettuce and other leafy plants.
- High-Intensity-Discharge (HID) – HID lights are great for all variety of plants. HID lights can be expensive, and they do create quite a bit of heat.
- LED lights are becoming more popular because they are low cost and use little energy.

There are several aspects to consider. Light can make all the difference in the success or failure of your garden:

*Type of Lighting* - vegetables need blue spectrum lighting. Fruits and flowering plants need a red spectrum. When it comes to full-spectrum lights, there is a wide variety and broad range.

*Amount of Time* – know how much time per day is needed for each of your plants and follow this, as explained above.

*Cost* – prices vary when it comes to light, so consider the amount of bulb, the cost for the power to generate the light, replacement costs, and how often bulb must be replaced.

*Heat Factor* – lights produce a varying amount of heat. Know what the heat output is for your plants. Ask if the information is not on the packaging, or look up online.

*Penetration* – know which lights penetrate deep into the plant, so the entire plant benefits, including the leaves.

*Power* – different lights give out different amounts of power or energy. Lighting can be expensive, so look for energy-efficient lights.

*Spectrum* – know the sunlight color needs of each of your plants.

## Lighting Tips

*Use a Timer* – vegetating plants, like leafy greens, root vegetable tops, and 30 to 60-day growth plants can require up to 12 – 20 hours of light. A timer helps, so you can oversee the proper lighting of your plants, even when you are away. Fruiting and flowering plants need 10 – 16 hours of light per day, depending on the variety. Required lighting is usually posted on seed packages on you can find this online.

*Heat Issues* – plants know their seasons by the day's length, otherwise known as the photoperiod, light spectrum, and temperature. If plants get too hot, or too cold, they can go into "thermal dormancy," meaning they won't correctly germinate and do not grow well. Know your plant's needs and weaknesses.

*Heat Burn* – there are many ways your plants can get heat burn. Possibly, through the type of lighting being used, like Metal Halide. If your plants are stressed (showing burning or crisping leaves), move the light higher and make sure there is proper ventilation. Air circulation is a must.

*Fixtures* – select ones that work best for your aquaponic system and you.

Taking the time to understand what lighting works best is one of the best things you can do for your fish and plants. In many ways, the same effort you give to your aquaponic garden is the same effort your garden will give back to you. Quality is a must when it comes to your garden.

## Chapter Seven Checklist

- Aquaponic plants need a lot of light
- Aquaponic plants need to be exposed to the full light spectrum
- Plants do not like lights on all day and night
- 25 watts per square foot is the standard lighting for aquaponic gardens
- Always consider heat factor, light penetration, and energy efficiency
- Use a timer

# Chapter Eight: Proper Heating

When it comes to an aquaponic fish tank, it can seem like nearly everything affects the tank's water temperature, namely:

- The size of the tank
- The steadiness of the heat source
- The surrounding climate
- All the items in the tank
- Where the tank is located
- Insulation amount

For your fish to survive, the temperature of the tank must experience as little fluctuation as possible. And tank temperature must be a huge consideration when choosing the type of fish you would like to grow. Some have wider temperature ranges than others, and like similar temperatures between fish must prevail.

The idea of relying on outside energy sources is one option. However, that solution could be costly. But, even more importantly, the reliance on one more system could create even more issues than it is worth. Others believe an outside source may be useful because there will be times when you might want to turn off your heater when you don't need it, and water cycling through a heater that is off might cool down the tank.

Some growers consider burying their tanks, but this does not work. The average ground temperature is 55 degrees, and other factors create their issues. However, some find success with this idea.

Many gardeners, when setting up their aquaponics garden, choose ornamental fish. Ornamental fish come from tropical gardens with a temperature as high as 78 degrees, not fully realizing that this temperature will need to be maintained throughout the tropical fish's life.

The most natural solution is to consider temperature when purchasing your fish and thinking in terms of the kind of fish you are buying as an all or nothing deal when it comes to fish and water temperature. All fish must be able to survive in the same temperature range. And there are some wide ranges available.

For tropical fish who do need a heater, there are two kinds of heaters:

- Submerged in the tank
- Mounted on the side

Both heaters can do the job. Just make sure the heater is sufficient to maintain the level of heat your fish need.

For fish in an average outside temperature of 76 degrees, you will not need a heater.

Fish tank heater solutions include:

- Solar water heater powered by a solar pump.
- Biogas generator with a heat exchanger
- A thermosiphon system
- A natural gas, tankless water heater with a low volume, high-pressure pump connected to 100 feet of pex hose that acts as a heat exchanger- a probes goes into the fish tank to turn the pump off and on, so as the water goes through it, the pump stops when the temperature gets too hot.

## Chapter Eight Checklist

- The size of the tank affects the heat factor
- The surrounding climate affects heat factor
- Location of tank affects the heat factor
- Fish do not like temperature changes
- Fish with similar temperature needs should be housed together
- Two kinds of heaters: submerged and side-mount

# Chapter Nine: Maintaining the System

Management of your aquaponic system is vital. Fish management involves everything from fish selection to harvesting your crops and (if desired) your fish.

This chapter will outline a daily, weekly, monthly schedule to make sure your aquaponic system is managed successfully.

The first matter of management is to make sure everything you do is within a clean environment. Not introducing anything to your fish or plants that would harm them is vital. This includes not sharing materials from one aquaponic garden to another.

Air pumps are vital – on this one, it's better to aim higher rather than lower when it comes to oxygen, but just make sure the aeration of your fish tank and plants is adequate.
Alarm systems help – for an aquaponic system that is so co-dependent, having an alarm system on pumps can make all the difference.
Know your fish food – because fish food is one of the only things you will add to your tank, you want to be sure the food you add is of the highest quality.
*Proper nutrient levels are a must* – could be considered the silent killer because it can't be seen, so it's hard to know, which is why testing is vital.
Proper resources – like everything else in life, aquaponics has its issues, and issues need to be resolved. Books like this, consultants, aquaponic friends, and acquaintances help. Pest control – make sure what you spray on your plants to help them, does not turn around and harm your fish. For the most part, the system takes care of its own, yet some issues can arise. In the aquaponic system, all systems are connected, so when handling one issue, consider how this will affect the entire system to be safe.
Quality of fish – make sure you know a reputable place for acquiring your fish.

Here is the breakdown for managing your aquaponic system:

Daily Management

Fish Tank:

- Add a fish if needed, and as ready to be added.
- Adjust pH, if necessary
- Check aeration. Make sure the air stone/pump is working well.
- Check for any leakage
- Check the temperature, adjust if needed
- Check to make sure water level is correct, add water, if needed
- Check to make sure the water pump is working. Water is moving
- Check water for water quality, remove any objects, food remnants
- Examine fish for any irregularities – stress, disease
- Feed fish (2 to 3 times a day)
- Remove any fish as needed for harvesting or other reasons.

Plants

- Check airflow in the area
- Check humidity
- Check plants for and changes in color, the health of foliage
- Check plants for pests: caterpillars, aphids, whiteflies, powdery mildew
- Check Roots
- Check the temperature
- Make sure the drainage system is functioning correctly
- Remove any plants necessary for harvesting or other reasons

Lights

- Burned out bulbs
- Distance from the plants
- Heat factor

Weekly Management

- Clean out any waste from the bottom of the fish tank and biofilter.
- Harvest fish add new ones as needed.
- Harvest plants, replant with new ones as needed.
- See if any plant fertilizer is needed for plant deficiencies.

- Siphon (vacuum gravel), if needed.
- Test pH, ammonia, nitrite, and nitrate. Make necessary adjustments as needed.

Monthly Management

- Add new fish, if needed
- Check all the systems to make sure they are working properly
- Clean all aspects of the fish tank and media bed that should be cleaned
- Clean biofilter and all other filters
- Take a sample fish and examine it for disease and weight gain or loss

It is one thing to build your system, and it is another to manage your system and keep it up to its highest quality. Your robust garden can be a prideful project to share with your family and friends.

## Chapter Nine Checklist

- The maintenance of the system should take place daily, weekly, and monthly
- Alarm systems can help alert when issues arise
- Only purchase fish from a reputable source
- Check fish, plants, lights, aeration, temperature, pH daily
- Clean the gravel in fish tank weekly or every other week
- Clean the biofilter and all other filters monthly
- Assess one fish thoroughly

# Chapter Ten: Tips and Troubleshooting

## General Tips

A few tips learned along the way are:

- Plants can die after transplanting. Make sure they get plenty of light and that their transplant from one environment to the next is similar. Plants do not like change, so try to minimize the move as much as possible.
- When fish are transplanted into a new environment, they can lose their appetite. Food for fish needs to be planned out in advance, meaning studied out as to what type and how much.
- Fish love hiding spots and are also known to jump out of the water when in a new environment. Make sure the tank is covered.

## Iron Deficiency and Aquaponics

Even though fish waste, broken down by bacteria, is the ultimate fertilizer for plants, deficiencies still arise. These include potassium, calcium, and iron. Potassium and calcium deficiencies are quickly resolved through proper pH balancing, but iron is a whole different story.

For the life of your aquaponic garden, you may never experience an iron deficiency. If you wonder if you have ever had one, then you probably have not. Your plant leaves would be yellow with green veins, called chlorosis.

Iron can be a little challenging to manage because iron is reactive to its environment. It is not always easy to identify an iron deficiency. If so, an iron checker can be purchased that will detect the deficiency. It can also read the amount of iron in your tank. The target range for iron in your system should be 2 – 3 parts per million (ppm). Signs of a deficiency will usually begin to show at around 1.5 ppm.

Once you have decided you need to add some iron, the solution must be better than the issue. This means not throwing in anything just because you know it contains iron, like rusty objects.

One solution to an iron deficiency is an iron supplement called Chelated Iron DTPA. This product provides aquaponic plants to get the iron they need to

survive, working with the plant's natural processes to absorb iron into their roots.

An organic solution could be found through iron-rich foods like liver, soybeans, lentils, spinach, chard, and kale. These can be added to homemade fish food that is blended at high speed and then frozen and cut to meet your fish's food requirements.

## Backup Battery Systems

One of the biggest fears of aquaponic growers is the loss of electrical power. After all the time you've given to your aquaponic system, one power outage could crash the whole system. No worries, there are some solutions:

- AquaBackup Battery-On with Oxygen Infuser
- Homemade Backup Systems
- Solar Backup Systems
- UPS (Uninterruptible Power Supply)

## Chapter Ten Checklist

- Plants can die after transplanting.
- A fish transplant from one environment to another must match
- Fish can lose appetite when transplanted
- Fish love hiding spots
- Iron can be a little challenging to manage because iron is reactive
- One solution is Chelated Iron DTP
- An organic solution can be found through iron-rich foods
- One of the biggest fears of aquaponic growers is the loss of electrical power
- There are several backup systems available

# Conclusion

Hopefully, you are reading this while enjoying your fresh, nutritious aquaponic salad, vegetables, and fish, thanks to the people who studied and worked so you could grow this type of eco-friendly garden.

There are a lot of valuable resources dedicated to the success of an aquaponic garden and many groups where you can receive support and have your specific questions and concerns answered, such as:

The Aquaponics Association:
aquaponicsassociation.org

American Aquaponics Facebook Group:
https://www.facebook.com/groups/163067483735761/

The National Agricultural Library, Aquaponics Division:
https://www.nal.usda.gov/afsic/aquaponics

The beauty of an aquaponic system is that you control the ability to have nutritionally healthy food available to you any time of day or night. Some systems are completely organic, without the use of electricity and other human-made dependencies, so your system can function independently.

Just as important as the food you receive following all your efforts is the beauty found in the process of working with nature in a completely new and sustainable way. Many find more than fruits, vegetables, and herbs in their gardens. We hope you do too:

"To plant a garden is to believe in tomorrow."
Audrey Hepburn

"No occupation is so delightful to me as the culture of the earth,
and no culture comparable to that of the garden."
Thomas Jefferson

"Life begins the day you start a garden."
Chinese Proverb

We hope you enjoy the journey and reap the rewards of your efforts not only in your garden but in all that you do.

# Description

Congratulations on purchasing *Aquaponics for Beginners*. How does this book differ from others? *Aquaponics for Beginners* walks you through all the steps, from planting to harvesting and everything in between. Filled with checklists to assure your "walk through" is complete, this book outlines the process, in simple terms, so that nothing is missed.

When it comes to an aquaponic garden, the proof of its success is found in the smooth, eco-friendly process and abundant harvest. This one-of-a-kind garden continually gains top-of-the-world attention because it brings together all the best gardening has to offer, including the ability to:

- grow anywhere, any time of year
- use 90 percent less water
- produce ten times the harvest of a soil garden
- harvest in half the time of a soil garden
- provide maximum nutritional value
- be fertilizer-free
- be pesticide-free
- be herbicide-free
- be virtually infestation-free
- be virtually destructive-free
- use minimal space

When it comes to an aquaponic garden, the hardest decision you'll make is deciding which type of container to use when harvesting all your new produce.

*Aquaponics for Beginners* presents a simple program to help you plan, set up, maintain, harvest, and enjoy the most robust garden you can imagine. Whether you've grown another type of garden before or this is your first time, this book has all the information you need to experience this fantastic growth process.

*Aquaponics for Beginners* helps you:

- determine the results you'd like to see
- create a plan to achieve this goal
- choose the right garden area
- decide which seeds you'd like to grow
- understand the fish water cycle system
- harvest your final product.

This book is your guide to all the answers you need, all along the way.

*Aquaponics for Beginners* includes the most comprehensive information laid out in the simplest way possible to give you the garden you've always dreamed of for less money and effort.

Every step of an aquaponic garden must be followed. For this reason, a specific order is given in this book, including such vital topics as:

- What Is An Aquaponic Garden and How Does It Work?
- Advantages and Disadvantages of an Aquaponic Garden
- Which Aquaponic System is Right For You?
- Mistakes to Avoid
- Items Needed

- Managing Your Garden Correctly
- Choosing the Right Grow Location
- Fish System Setup
- Media System Setup
- Sump Tanks
- Right Lighting and Temperature is Key
- Signs of Plant Trouble and How to Resolve Them
- Enjoying the Harvest
- What To do About Downtime/In-between Cycles

Taking the topics and exploring each one in detail allows you to understand the many dynamics of an aquaponic garden more fully. Becoming familiar with each step brings more satisfaction to the process. Ending with food on your table is the ultimate achievement of the successful aquaponic garden and one you'll be glad you chose.

There are plenty of books on this subject on the market, thanks again for

choosing this one! Every effort was made to ensure it is full of as much useful information as possible; please enjoy!